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ABSTRACT

These workshop papers address the challenges of alternative credentials, new modes of instruction, and multiple sources of instruction. Following an introduction by Nevzer G. Stacey, "Competence without Credentials: Promise and Potential Problems of Computer-Based Distance Education" (Stephen R. Barley) provides a conceptual framework for the workshop. "Are Employers' Recruitment Strategies Changing: Competence over Credentials?" (Laurie J. Bassi) explores what types of firms use computer-based learning and for what purposes. It examines how employers assess competence in the hiring process and how changes in the labor market and other environmental factors have led firms to experiment with computer-based learning. "High Tech vs. High Touch: Potential Promise and Probable Limits of Technology-Based Education and Training on Campuses" (Kenneth C. Green) explores trends in computer-based education among colleges and universities and opportunities and problems they face as they move into computer-based learning. "Learning Tools within a Context: History and Scope" (Charles N. Darrah) describes computer-based learning opportunities available via the World Wide Web and discusses how social contexts of users may affect use of the medium. "Employers as Course Developers: Are They the New Educational Institutions?" (Thomas Edgerton) provides an overview of Sun Microsystems philosophy and approach to computer-based learning for its employees. "Summary of the Workshop" (Beth A. Bechky) suggests future research questions. "Conclusion" (Nevzer G. Stacey) highlights themes that emerged from the workshop. (YLB)

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Introduction

Nevzer G. Stacey

The National Institute on Postsecondary Education, Libraries, and Lifelong Learning (PLLI) of the U.S. Department of Education commissioned papers and held a workshop in September 1997 on computer-based learning and its implications for employers and traditional postsecondary institutions. *For the purpose of this workshop, computer-based education was defined as employing computers to gather and use information that has been transmitted electronically from other sites. The term computer-based education does not refer to traditional use of computers in the classroom.*

The rationale for the workshop grew out of the knowledge that technology is moving swiftly into the education market, creating opportunities as well as challenges for learners, employers, and educators in the 21st century. A number of trends are observable already, including the pace of development of new learning resources available on personal computers and through the Internet, the shorter periods between retraining cycles in business and industry, and changes in the course-taking patterns of traditional students. Educational institutions, employers, and adults who participate in alternative learning strategies have a great deal at stake as these events continue to gain momentum. Furthermore, there seems to be a disconnect among course developers, such as trainers who work for consulting firms and professors who work for universities, as each one represents a different learning culture.

Such general trends have led to specific challenges that the workshop was designed to address:

- *Alternative Credentials.* Historically, employers have used educational credentials as signaling devices for hiring. Diplomas and degrees are considered signs of competency that help employers make better matches between individuals and jobs. But employers are beginning to view diplomas and degrees with skepticism as technological and structural changes escalate. Employers are beginning to seek new signals in recruiting or retraining employees. Initial signs of competencies developed through computer-based learning are becoming one of the alternative signals.

- *New Modes of Instruction.* New learning opportunities on the Internet in the United States and overseas have been mushrooming. This is both very exciting and very challenging. For example, about 9 percent of all college courses currently use World Wide Web-based resources to support instruction, up from 6 percent in 1995 (Green 1998). Cigna Corporation has teamed up with Drexel University in Philadelphia to offer an online master's degree program in information services. Another university that provides online master's degree programs is the University of Phoenix, chartered in 1978, which is now the second largest private college or university in the United States. Among others are McGraw Hill University, Ziff Davis University, and University on Line.

- *Multiple Sources of Instruction.* Another reason for focusing on the development of courses on the Internet is the increasing number of multisource courses of study available to learners. For example, a computer-consulting firm based in Harwich, Massachusetts, offers online courses for consultees from 700 universities around the country. As working adults return to education to upgrade their technical knowledge and skills, they are more likely to attend a variety of institutions in a number of different locations. We are observing this course-taking pattern even among traditional students.

Many similar issues are important to postsecondary institutions. Will the fast rate of course development in alternative learning environments, especially in scientific areas, cut into the traditional postsecondary institution's market? How will traditional institutions compete with nontraditional vendors who develop courses? If traditional educational institutions do not offer these options, will they be able to survive financially? Will the availability of highly technical postgraduate-level learning opportunities on the Internet escalate the growing disparity between highly educated learners and learners with little education? Is a terminology common so that customers and employers know what is provided under a specific title? Are all these courses and learning resources subject to similar scrutiny? Who is responsible for quality control? How does one assess the quality? Are employers, as customers, able to assess the courses? If the desired goal is to have learners with less education engage in more study, who should worry about the quality of resources the learners pursue? Is it possible that the less educated may end up being more confused and unable to decide what has quality and what does not?

To discuss these issues and frame research questions, PLLI sponsored a one-day workshop in cooperation with the World Bank and the Center for Work, Technology, and Organization, of the School of Engineering, Stanford University. PLLI commissioned four papers to address these issues from different perspectives. A small group of experts composed of employers, representatives of higher education institutions, associations, and the federal government convened to discuss these papers and the issues outlined. The papers and the discussion generated even more questions. Following this Introduction Stephen Barley provides a conceptual framework for the workshop.

The first two papers examine the growth of courses on the Internet that have been developed by firms and institutions of higher education. In "Are Employers' Recruitment Strategies Changing: Competence Over Credentials?", Laurie Bassi draws on a survey of employers' training and recruitment practices collected by the American Society for Training and Development, and on other data, to explore what types of firms utilize computer-based learning and for what purposes. The paper provides information on how employers assess competence in the hiring process and examines how changes in the labor market and other environmental factors have led firms to experiment with computer-based learning. Kenneth Green's "High Tech vs. High Touch: The Potential Promise and Probable Limits of Technology-Based Education and Training on Campuses" uses data from the 1996 Campus Computing Survey to explore trends in computer-based education among colleges and universities in the United States. Green details the opportunities and problems that higher education institutions face as they move into computer-based learning.

The third and fourth papers focus on the level of practice from the perspective of users and developers to provide the kind of contextual knowledge currently lacking in most discussion of computer-based learning. In "Learning Tools within a Context: History and Scope," Charles Darrah describes computer-based learning opportunities currently available via the World Wide Web. Darrah discusses how the different social contexts in which users are embedded are likely to affect the use of the medium. Darrah sounds a note of caution for predictions that the Web represents an important source of training for individuals outside corporate and university settings.

Thomas Edgerton's "Employers as Course Developers: Are They the New Educational Institutions" provides an overview of Sun Microsystems philosophy and approach to computer-based learning for its employees. The paper reviews the details of several specific projects, provides empirical evidence of efficacy, and discusses both the opportunities and constraints that Sun has encountered in its efforts to develop computer-based learning modules.

Beth Bechky summarizes the workshop discussions and suggests some unanswered questions that need to be explored. The publication ends with a conclusion, including a series of themes that emerged from the workshop.

Competence Without Credentials: The Promise and Potential Problems of Computer-Based Distance Education

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Over the last decade, institutions of higher education, state and federal agencies, corporations, and the public at large have become increasingly interested in "distance" or "distributed" learning. Although there is considerable debate about what these terms mean, especially among proponents of different educational philosophies and technologies, almost everyone who is party to the debate agrees on the motivating premise. Whereas education has traditionally meant bringing students to sources of knowledge, the time has come to bring sources of knowledge to students.[1]

Historians of education will quickly note that attempts to deliver education outside the walls of a classroom are not new. The extension divisions established by American agricultural colleges after the Agricultural Extension Act of 1914 were nothing less than a massive attempt to bring the fruits of modern agricultural science to farmers in their fields and communities. Numerous trade and technical schools have long offered credentials through correspondence courses. Educators viewed television, almost from its inception, as a means of educating students who need not set foot in the classroom. Since the 1960s, numerous colleges and universities have experimented with televised education, and some have had considerable success with television as a delivery medium. Stanford's Instructional Television Network (SITN), which has broadcast courses to people employed by firms inside and outside the Silicon Valley for almost two decades, and Britain's Open University, which was founded specifically to provide degrees at a distance, are notable examples. But even though the idea of distance education may not be new, the perception is widespread that it is only now entering an era of its own. The renewed promise of distance education rests on a confluence of economic and technological developments that are setting the context for the 21st century.

Why Is Distance Education Attractive?

Of central importance is the changing nature of work in the Western nations and Japan. Blue collar and clerical work in all industrial societies have declined significantly since the 1950s, while managerial, service, professional and technical work have steadily grown. At the beginning of the 20th century, 83 percent of all Americans held jobs that involved working with things (e.g., farmers, operators, laborers, or craftspeople). By the year 2000, this percentage will have been halved (41percent). Conversely, the percentage of Americans whose jobs involve working with people or information (e.g., salespeople, managers, administrators, professionals, and technical workers) has expanded from 17 percent in 1900 to 59 percent today. The professional and technical workforce became the largest occupational sector in the United States in 1991 (Barley 1996a). In short, intellectual capital and knowledge work are rapidly replacing physical capital and production work as the source of economic prosperity (Stewart 1997). We seem to be witnessing the coming to pass of Bell's (1973) post-industrial economy.

The shift to knowledge and technical work has important implications for the role of education in society. To the degree that intellectual capital becomes pivotal to the economy, people will increasingly require higher levels of education if they are to be meaningfully, if not gainfully, employed. Because technical knowledge changes so rapidly, as work becomes more technical the need for continual training and retraining will escalate. In such a world, traditional models of education that require an extended "time-out" from productive activity will prove increasingly unreasonable and expensive, especially for adult learners with families. In this new world of work, the economies that flourish will likely be those in which easily accessible education and lifelong learning also flourish.

Fundamental changes in the nature of work are not, however, the only developments driving experimentation with distance learning. The globalization of markets, coupled with the trend toward less hierarchical, more geographically distributed organizations, make it less feasible for firms to rely on the kind of centralized classroom training that has long been the stock and trade of corporate training and development. Furthermore, because technical practices change so quickly and because so much technical knowledge is contextual in nature, most schools and universities are poorly equipped to provide the kind of training and experience that a technical workforce needs to remain up to date. Indeed, technical workers routinely acknowledge that on the job they use very little of what they learned in school (Barley 1996b). A growing number of firms have therefore come to view distance education as a way of meeting the workforce's need for up-to-date information and continuing education. Distance education promises firms the option of providing training on an "as needed" basis to individuals on a wide range of topics, many of which could not be justified as part of a school's curriculum.

Ultimately, however, technological change may be the strongest reason for renewed interest in distance learning, for even though economic changes may have exacerbated the need for continual education, new technologies have created the opportunity and the means for addressing the need. Earlier approaches to distributed education constrained delivery in significant ways. Extension operations required the co-presence of teacher and student as well as a classroom in a remote location where students could assemble. Televised instruction eliminated the need for co-presence, but introduced problems of asynchrony. Students in televised courses were often unable to ask questions of teachers during the course of a lesson, if at all. Except in expensive, specially equipped facilities that enabled live, two-way broadcasts, distance learning via television was largely a passive activity.

The dramatic emergence of the Internet and, more recently, the World Wide Web, have suddenly created, at least in principle, a way of transcending many of the problems associated with earlier forms of distance education. Web technologies are capable of delivering text, data, images, audio, and video in an integrated and coordinated manner. Moreover, "chat" rooms that allow nearly synchronous e-mail exchanges, electronic whiteboards that allow people to co-produce drawings at a distance, and fledgling imaging technologies that bring two-way, live video to a computer screen (such as CUseeme and Placeware's Auditorium) open the possibility of real-time exchanges, not only between students and teachers who are separated in space but among students who are themselves distributed. Finally, because computers are prevalent in the workplace, computer-based training (CBT) and Web-based training (WBT) can provide multiple users with access to training materials and to each other without anyone leaving their desks.

Proliferating Experimentation

The combined force of economic pressure and technological opportunity has encouraged schools and firms to experiment with Web-based distance education. The rapidity of the response is staggering. Easy access to the Internet has been available for less than a decade, and the advent of the World Wide Web is even more recent. Yet, numerous institutions of higher education have already targeted the market for distance education. In 1995, the governors of Colorado, Utah, and several other Western states established the Western Governors' University (WGU) with the purpose of exploiting information technologies to deliver higher education to students distributed over time and space (Epper 1996; www.westgov.org). Green (1997) reports that the University of Phoenix, which relies heavily on distance education of all forms, has become the second largest private university in the United States enrolling more than 31,000 students. The New School for Social Research in New York City now offers bachelor's degrees through its Distance Instruction for Adult Learning program (DIAL). Students can register for and take DIAL courses over the Internet, through many of the courses still require students to purchase books and other materials (www.dialnsa/edu/dial.html). The Mind-Extension University (www.meu.edu) also offers degrees via the Internet.

Although most schools offering degrees on the Web are not household names, many better known universities are also experimenting with computer-and Web-based instruction, at least on campus. Stanford's Engineering School has been particularly active in distance education. Stanford recently hired a cadre of technically trained curriculum support staff and assigned them to departments to work with faculty in developing courses for the Web. Approximately a quarter of all institutions of higher education responding to the 1996 National Survey of Information Technology in Higher Education reported that similar goals were of significant priority (Campus Computing Report 1996)

Firms and government agencies are also moving into distance education. A number of corporations, faced with the increasing need for continual training, a distributed workforce, and the promise of significant cost saving, have established distance learning programs. Some, such as Motorola and Sun, believe that training offers such a crucial competitive advantage that they have established their own "universities" for their employees. Within the federal government, the Department of Energy has been active in developing Web-based training, especially around issues of safety and the handling of hazardous materials (www.orau.gov/tmsd/trade/siginfo/att/ ebtrain.htm).

Corporations with technical expertise have also begun to contract with their customers to provide them with distance-based training. IBM's Global Campus and the Lotus Institute, for example, not only offer distance learning software but assist in skills assessment, curriculum design, and certification (www.training.ibm.com, www2.lotus.com). In 1996, the Department of Defense awarded Sprint a $50 million contract to develop a Tele-Video Training Network for the Army Training and Doctrine Command (press release, www.sprint.com). Netware Users International, an association of Novell networking professionals, currently offers training in network technology via the internet through CyberState University (Business Wire 1997). Through online courses, technicians can become Certified Novell Engineers, Certified Novell Administrators, and Microsoft Certified Systems Engineers. Ziff-Davis, a publisher of well-known computer magazines such as *PC Magazine* and *Windows Magazine*, caters to individual distance learners. Ziff-Davis runs the Internet-based ZDNet University which specializes in Web-based instruction in programming languages and software applications (www.zdu.com). For $4.95 per month, students can take as many ZDNet courses as they want.

Finally, the advent of the Web and the increased need for training have spawned considerable entrepreneurial activity. The last several years have witnessed the founding of firms dedicated to developing software and hardware for supporting distance education, to building specific training modules, or to providing consulting assistance to firms that want to mount their own distance education programs.

Unanswered Questions

Although computer-based training and distance education hold considerable social and economic promise, it is important to recognize that the promise rests largely on high hopes for a fledgling set of technologies. As with most new technologies, the realities of implementing Web-based education are likely to be different than the proponents rhetoric implies. We know from studies of other technologies, such as word processing and computer-aided design, that anticipated benefits may be less easily achieved than originally thought (Sproul and Keisler 1991; Salzman 1992). Embedded practices and unanticipated side effects often slow technology diffusion, counteract intended consequences, and lead to undesirable secondary outcomes (Barley 1988). For instance, although firms claim that "intranets" will create efficiencies and change the way they do business, research currently being conducted by Francois Barr (Department of Communications) and Neil Kane (Department of Industrial Engineering and Engineering Management) at Stanford suggests that most firms that have constructed intranets are actually doing very little of significance with the technology.

Even if Web-based technologies do occasion a fundamental restructuring of the way education is delivered, doing so will, by definition, alter embedded institutional arrangements and cultural practices. If the goal is to provide greater access to knowledge and opportunity and if one believes that distributed education is key to achieving this goal, then failing to take institutional, demographic, and cultural issues into account may thwart the larger objective. At present, important practical, social, and institutional questions remain unanswered, in part, because of the speed at which Web-based technologies have been so enthusiastically embraced. Because the technologies driving the development are so new, researchers have yet to study their use, and users have not had sufficient time to accumulate the wisdom of experience. Among the questions that need to be answered if we are to go beyond the rhetoric and realistically assess the future of distance education are the following:

- *How prevalent are the new forms of distance education?* We know that a number of highly visible schools and corporations are experimenting with computer and Web-based education, but we do not know how representative they may be. It would be useful to know the characteristics that distinguish corporations and schools that offer distance curricula from those that do not would be useful. We also do not know how many students or employees are actually taking advantage of opportunities for distance education and we know even less about the attributes of those students. Without such information we can not determine whether distance education is reaching those who might not otherwise have access to knowledge or simply reaching those who already take advantage of most other educational opportunities.

- *Are there practical and cultural barriers to distance learning?* Although many schools want to move into distance education, as Green (1997) has noted, most universities simply do not have the technological infrastructure, the financial wherewithal, or the technical talent to allow them do so in a concerted way. Similarly, even though a growing percentage of households have access to computers, access is highly stratified by socioeconomic class. Access may be similarly stratified among business

organizations: larger, wealthier firms may be able to provide access to distributed education while smaller, less profitable firms may not. What are the implications of such stratification for the goals of distance education and how do we overcome these barriers?

- *What are the firms and schools that are experimenting with distance education actually doing, and what are they learning about using Web-based technologies?* Although firms and schools regularly report their general involvement with distance-education, there is little specific and systematic information about what any organization has actually done. More importantly, little is known about what firms have discovered about the limitations and opportunities of Web-based courses. Surfacing such data is critical for accurately assessing the potential of distance-based education and for fostering a community of practice around development.

- *How can we characterize the content of courses currently taught via Web-based education?* Due to the nature of the medium, we need to know which subjects are most amenable to Web-based education. Some limitations are likely to be technological. For instance, even though Web-based education can be a multimedia affair, technical and economic realities (such as bandwidth and cabling) are likely to pose constraints on implementation. Other limitations may be social. If early developers are technical people, then all else being equal, their courseware should highlight technical information. Finally, some limitations may be inherent in the medium itself. For example, technical skills are often difficult to learn except by doing, and some even require face-to-face interaction with more accomplished members of a community of practice (Orr 1997). It is difficult to comprehend how the Web could simulate such learning.

- *How does the context of distance learning differ from the context of more traditional forms of learning?* All teaching and learning takes place in a context. We know that the context of learning is crucial for educational outcomes. However, aside from pronouncements that learners need no longer travel to classrooms and that they can learn at their own pace, we know next to nothing about the context in which distance-based learning occurs. What sort of background knowledge do students need in order to locate appropriate courses and providers? When students take courses at their desk or at home, how does the immediate environment affect the learning process? How do the temporal structures of distance learning differ from the temporal structures of classroom learning, and do the differences matter? Unless we understand the context of distance learning, we are unlikely to understand how the technologies can be optimally used.

- *How do employers assess competency with distance-based education?* Historically, schools have provided credentials and certifications. Students who pass through a curriculum are exposed to specific content (sometimes in a specified sequence), and their performance is assessed via grades and attested to with diplomas. Schools and departments within schools are examined by external accrediting agencies that certify quality. Furthermore, schools vary in their reputation for faculty and students, thereby providing additional information that allows employers to assess the adequacy of a student's preparation. No such institutions currently exist to attest to the quality of instruction or learning via distance education programs. In the absence of schools, credentials, and accrediting bodies, how will employers and other organizations assess the value of their employees' education and determine whether they have mastered the skills and knowledge they purport to have learned? How will employers compare knowledge, skills and degrees acquired via the Web with the same training acquired in more traditional educational settings?

- *How will students assess the relative utility of different training opportunities?* Credentials, accreditation, and reputations also provide students with a means of distinguishing between different providers of education. In the absence of such signaling devices, students may have difficulty assessing the relative utility and quality of alternative educational experiences before spending their money. To the degree that firms rely on distance courses developed and supplied by vendors, they are likely to suffer similar confusion.

- *What are the implications of the blurring of institutional boundaries*? Although firms have always offered training, most has been "hands-on," or else focused on managerial skills such as leadership and team building. Schools have historically served as the provider of general education and structured forms of training. As firms move into the business of education and offer types of courses more traditionally found in schools, the boundaries between the two kinds of institutions may blur. What can we expect if firms and schools, in essence, begin to compete for students?

Note

1. In general, distance learning refers to the delivery of a curriculum to students who are not present on campus, while distributed learning is most often used to connote ways of facilitating interaction among those distant students. For the sake of simplicity, I shall use only the term "distance learning" because it is the broader of the two terms: distributed learning can be understood as a type of distance learning.

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Are Employers' Recruitment Strategies Changing: Competence Over Credentials?

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The field cannot well be seen from within the field.
— Ralph Waldo Emerson

Human capital, mercifully, is the only form of capital that corporate America cannot buy or sell. As a result, it is the only form of capital that does not have well-defined (if admittedly grossly imperfect) accounting procedures and reporting rules associated with it. In part because of this, firms' procedures for assessing and valuing the competencies of prospective and incumbent employees range from primitive to nonexistent. Another factor contributing to the sorry state of assessing workplace competence is that in times of rapid change (such as we are currently in), employers' concepts of what constitutes competence also change rapidly; these concepts, however, are rarely well defined and articulated. Still another factor complicating the difficulty of assessing and valuing workers' competencies is that the methods by which these competencies can be created are expanding faster than is our collective capacity for evaluating the effectiveness of these methods. Finally, human beings are extraordinarily complex; participating in well-honed, highly effective learning experiences is no guarantee that any given participant actually learns anything at all.

In sum, there are many reasons why assessing competence is inherently difficult and becoming even more difficult with the passage of time. There are also reasons to believe that the imperative to tackle this difficult task is becoming more pressing.

This paper examines evidence from a variety of perspectives that are relevant to understanding the changing nature of workplace competence. Four perspectives are considered: the operation of the labor market, surveys of what employers say, the market for employer-provided training, and the stock market.

What the Labor Market Is Telling Us

Over the past 25 years, 2 striking trends have dominated all others in the labor market. First, real (i.e., inflation-adjusted) wages have fallen for the majority of workers. Second, dispersion of wages—both within and between groups—has increased.

Historically, real wages have been driven by productivity changes.[1] The period since 1973 has been no exception. Between 1961 and 1972, productivity grew at an annual rate of slightly more than 3 percent; between 1973 and 1994 the productivity growth rate fell by more than 60 percent, to an annual rate of less than 1.2 percent.[2]

Consequently, understanding the productivity slowdown is tantamount to understanding the real wage decline. Unfortunately, while a wide variety of explanations have been put forth, the slowdown in U.S. productivity remains largely unexplained. What is clear, however, is that widely heralded changes in technology have not yet manifested themselves either in growth of productivity or wages.

The combined effect of the increase in wage dispersion, along with the decline in real wages has been most pronounced for males. The real hourly earnings of men with less than a high school education, for example, fell by 28 percent between 1973 and 1995. This decline has been most pronounced for young men.

The only groups that have enjoyed increases in real earnings are women with at least a college education and men with advanced degrees (see table 1).

Table 1.—Percent change in real hourly wage by education: 1973–1995

Education level	Men	Women
Less than high school	-28	-7
High school	-19	-3
Some college	-15	-1
College	- 4	+8
Advanced degree	+12	+6

Source: Lawrence Mishel, Jared Bernstein, and John Schmitt. The State of Working America 1996–97. Armonk: M.E. Sharpe, Inc., 1997.

These shifts in earnings patterns have been occurring at the same time that the average education level was increasing quite sharply. For example, between 1975 and 1994, the percentage of adults (age 25 years old and over) who had graduated from high school rose from 63 to 81 percent with the corresponding figures from college being 14 and 22 percent (U.S. Bureau of the Census, *Statistical Abstract of the United States 1995*, page 157). In other words, the supply of highly educated workers increased. Since the relative (and in the case of women, the absolute) wages of college graduates rose as the supply rose, demand for educated workers must have risen even faster than their supply; otherwise the wages of highly educated workers would have fallen.

It is less clear, however, what is behind changes in demand for highly educated workers. Like the mystery of the slowdown in productivity growth rates, there is no widely accepted explanation of what accounts for the rise in U.S. wage inequality. Outcomes in the labor market are a complicated interaction of not only supply and demand but also institutional factors (e.g., the minimum wage and unionization). Table 2 summarizes the results of a recent survey (conducted by Alan Krueger as a part of the New York Federal Reserve Colloquium) in which a group of economists was asked to assign responsibility for rising wage inequality to a variety of factors (table 2).[3]

Table 2. —Causes for the rise in U.S. wage inequality? (In Percent)

Potential cause	NY Fed Colloquium Survey
Demographic shifts	4
Immigration	7
Decline in real minimum wage	9
Decline in unionization	9
Technological change	40
Trade	11
Other	15
Don't Know	9

Source: Alan Kreuger.

Table 2 indicates that, as a group, economists believe that technological change (which affects the demand for various groups of workers) is the single most important source of rising inequality of wages, accounting for an estimated 40 percent of the increase. Looked at more expansively, however, even more of the increase in inequality might be attributable to technological change. Richard Coopers, for example, argues that trade (i.e., increasing globalization) is inseparable from technological change.[4] Similarly, at least part of the decline in unionization is undoubtedly attributable to trade, and therefore, by extension to technological change. Adding together the effects of these forces suggests that technological change might account for as much as 60 percent (40 + 11 + 9) of the rise in wage inequality in the United States.

In sum, the consensus of the economics profession is that technology has had a very significant (perhaps even unprecedented) effect on the demand for highly educated workers.

What these statistics do not tell us, however, is why this is so. Unfortunately, very little is known on a systematic basis that enables us to identify in a rigorous manner exactly what is behind the shift in demand for educated workers. Levy and Murnane have, however, uncovered one tantalizing shred of empirical evidence. And that is that across occupations, the return (in the form of a wage premium) on mathematical skill has increased significantly over the time period under consideration (Levy and Murnane 1992). Since it is unlikely that the use of mathematics has increased significantly over all occupations, this suggests that mathematics skills may be a proxy for some other skill increasingly in demand by employers, perhaps the ability to solve problems (which is, essentially, what mathematics teaches).

Another tantalizing fact that has emerged is that the increased dispersion in earnings *across* age/gender/education groups has been accompanied by an equally large increase in the dispersion of wages *within* each of these groups (Levy and Murnane 1992). That is to say, while education is an increasingly important determinant of wages, so too is something else. But we don't know what that something else is. There are many possible explanations. It could be that the return on competence has increased. Or it could be that in an economy that is undergoing rapid change there is an increasing payoff to being in the right place at the right time (i.e., luck).

A recent analysis of wage patterns over the course of decades (Autor, Katz, and Kreuger 1997) has detected patterns between people's use of computers at work and variations in wages. The authors conclude that "computer technology may 'explain' as much as 30 to 50 percent of the increase in the rate of growth of the wage-bill share of more-skilled workers since 1970."[5] Consequently, use of computers at work "explains" both the increase in wage dispersion across educational groups as well as within educational groups.[6]

Taken together, these labor market trends suggest the following conclusions. First, education credentials are an increasingly important determinant of demand for labor, which in turn, affects wages. Second, it is not clear whether employers are increasingly relying on education credentials as a method of screening for the skills they need, or whether these credentials are merely a proxy of increasing importance for some necessary skill (perhaps the ability to learn quickly). Third, the demand (as evidenced by the growing wage premium) for mathematics skills has grown. It may be that these skills serve as a proxy for some other important skill (such as problem-solving ability). Fourth, since wage inequality has also increased *within* educational categories, some aspect of supply and demand (above and beyond educational credentials) is at work in the labor market. This could be some unmeasured competencies. Or it could be luck. Or it could be something else. Fifth, the use of computers is likely to be an important part of the "something else." Finally, it is simultaneously true that both educational credentials and something beyond educational credentials have become increasingly important in determining employers' demand for workers, and therefore, the wages that workers earn. It is likely that both competence *and* credentials are increasingly in demand by employers.

To paraphrase Emerson, it isn't easy to figure out what's going on when you are in the middle of what's going on ("The field cannot well be seen from within the field"). As the conclusions outlined above make clear, an analysis of labor market data can reveal much about what is happening, but little about why things happen. The review of opinion surveys that follows represents one method for developing hypotheses about why these labor market trends are occurring.

What Employers Are Telling Us

Insight sometimes has to be gained at the expense of rigor. Although simply asking people to share their opinions about why things are happening the way they are is not terribly rigorous, nonetheless it can be insightful. The advantage of this approach is that it is possible to get much more timely and detailed information than that which can be gleaned from the operation of the labor market. The disadvantages of this approach are: (1) it is based on a limited sample (of either employers or employees) and (2) people's perceptions and their actions (i.e., the actual choices they make in the labor market) are not necessarily entirely consistent with one another.

Nonetheless, in survey after survey about skill requirements, employers report skill deficiencies. The severity of these complaints varies over the business cycle, inevitably worsening as the labor market tightens. What is not clear from these surveys is whether employers' complaints about skill deficiencies have become increasingly severe over the course of recent decades, or whether these complaints merely reflect employers' age-old complaints that workers' wages are higher than employers would prefer to pay.

Surveys of employers consistently find that computational and problem-solving skills are among the most serious "hard" skill deficiencies, although inadequate writing and verbal skills are also reported to be a problem. Among entry level workers, however, deficiencies in interpersonal skills, poor attitudes toward work, and difficulty "fitting in" are consistently reported as serious (chapter 5, Cappelli et al 1997).

The results of a recent survey sponsored by the Society for Human Resource Management (SHRM) are reported in table 3 (Aon Consulting and SHRM, *The 1997 Survey of Human Resource Trends Report*, U.S. edition, 1997).

In general, employer surveys suggest that employers are experiencing a fair to moderate degree of difficulty in filling entry level jobs, and somewhat more difficulty in filling higher level jobs that require specific skills (see table 3).

Table 3.— Percent of firms that rated competencies as "weak" among nonmanagement job applicants

Competency	Percent
Dealing with change	44
Problem solving/reasoning	43
Creativity/innovation	42
Communications	41
Basic skills (reading, writing, math)	38
Interpersonal/team skills	37
Work orientation	37
Technical/business skills	36

Source: Aon Consulting and the Society for Human Resource Management, The 1997 Survey of Human Resource Trends Report.

The range of tools that employers use to help them select among job applicants are summarized below in table 4 (based on SHRM survey). As is typical in this type of survey, the response rate was low—12 percent. The total usable sample was 1,700. No analysis was presented of differences between respondents and non-respondents, but it is clear that large firms are over-represented in the sample. As a result, it is likely that the respondent firms are more sophisticated in their human resource policies and strategies than a representative sample of firms.

Table 4.— Prevalence of selection procedure use for nonmanagement and management candidates (percent of firms that report using the certain techniques)

Procedure	Nonmanagement	Management
Reference checks	95	96
Structured interviews	74	73
Background checks	70	73
Drug tests	68	64
Structured applications	63	60
Skill tests	55	23
Realistic job previews	30	27
Personality tests	18	22
Job simulations	13	9
Assessment centers	7	9

Source: Aon Consulting and the Society for Human Resource Management, The 1997 Survey of Human Resource Trends Report.

Despite the probable nonrepresentativeness of the sample, it is nonetheless of interest that a majority of responding firms (55 percent) report using skills tests to assess nonmanagement job candidates. A variety of other methods for assessing competencies (realistic job previews, job simulations, and assessment centers) are used by fewer employers. Unfortunately, there is no time-series data on the prevalence of these practices. As a result, it is not known whether their use is rising or falling. Nonetheless, the results suggest that firms use a variety of methods (above and beyond screening education credentials) to assess competence.

Interestingly enough, the SHRM survey results indicate that these methods may have only a modest effect on employers' satisfaction with the effectiveness of their selection procedures. These results, summarized in table 5, indicate that using skills tests increases by 14 percent the probability that employers report that they are satisfied with their selection procedure. (Note that the independent effect of skills test on satisfaction must be inferred from table 5 by solving a set of simultaneous equations, which yields the estimate of 14 percent.)[7]

Given the difficulty and expense often involved in developing and implementing valid skills tests, an incremental 14 percent increase in satisfaction with these (probably expensive) selection procedures is somewhat disappointing. This suggests that employers may face a substantial challenge if more and more skills are acquired through nontraditional means (such as the Internet), and fewer skills can be verified through traditional methods (such as checking credentials). On the other hand, the finding that only 36 percent of employers report they are satisfied with the effectiveness of their traditional basic selection tools (which includes checking credentials) indicates that employers are less than satisfied with traditional measures of assessing job applicants' qualifications (see table 5).

Table 5.— Percent of firms reporting satisfaction with selection procedure effectiveness as a function of procedures used

Procedure used	Percent
Basic selection tools (background and reference checks, ability tests)	36
Plus structured applications and interviews	58
Plus structured applications and skills tests	61
Plus structured interviews and skills tests	61

Source: Aon Consulting and the Society for Human Resource Management, The 1997 Survey of Human Resource Trends Report.

What the Training Market Is Telling Us[8]

Private employers spent approximately 1.8 percent of their payroll on training in 1995. This spending was split nearly equally between direct and indirect costs (compensation of employees while in training), with each amounting to approximately 0.9 percent of payroll.

The following listing ranks industries from high to low according to their spending on formal employer-provided training: transportation, communications, and public utilities; mining, finance, insurance, and real estate; nondurable manufacturing; wholesale trade; durable manufacturing; services; construction; and retail trades.

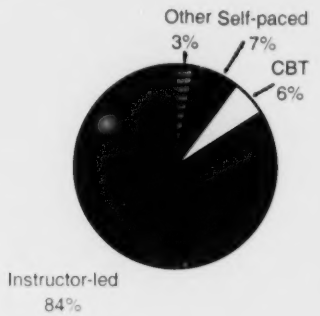
Household survey data indicates that in 1995, 16 percent of the civilian workforce—approximately 20 million workers—reported that they received formal employer-provided training within the previous year.[9] Workers with high levels of education are more likely to receive employer-provided training than are workers with low levels of education. Mature workers are more likely to receive training than are younger workers. Men are somewhat more likely to receive training than are women. Whites are more likely to receive training than are minorities.

Throughout the 1980s and 1990s, spending on employer-provided training appears to have increased faster than the rate of inflation. This increase in spending, however, does not appear to have kept pace with the increase in the number of workers. Consequently, training expenditures per worker have fallen somewhat.

At the same time, the percentage of workers receiving employer-provided (or required) training has increased sharply, growing from 5 percent of workers in 1981 to 16 percent of workers in 1995 (once again, based on household surveys). This suggests that expenditures *per worker trained* have fallen significantly.

One possible explanation for at least a portion of this decline is that as more workers are trained, the type of worker being trained has undoubtedly changed. For example, if more production workers are being trained and this training is relatively inexpensive, this change could result in lower costs per worker trained.

Figure 1.—Training time by delivery system



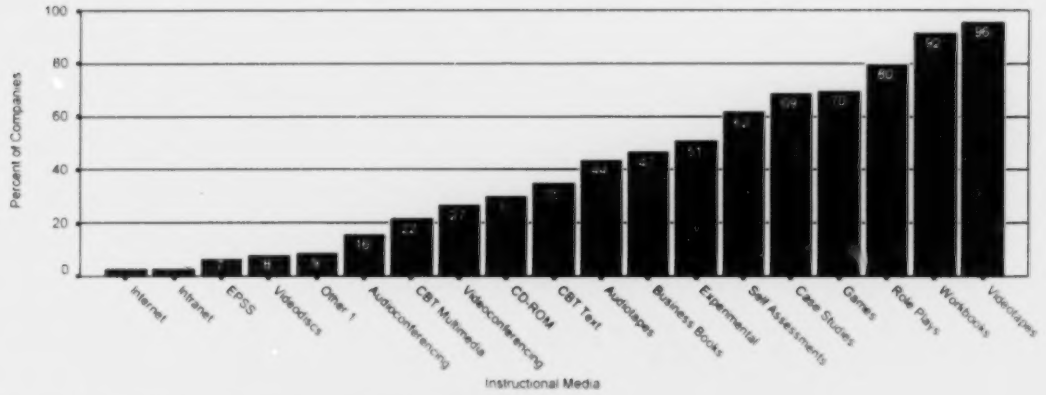
Source: ASTD's 1997 Human Performance Practices Report.

Technology is another possible explanation for the decline in expenditures per worker trained. As technology has enabled training to be delivered through low-cost methods such as electronic performance support systems and computer-based training, the cost per worker trained would be expected to fall.

Unfortunately, there is very little reliable time-series evidence on the extent to which employers use learning technologies to deliver education and training to their workforces. A recent survey done by the American Society for Training and Development (ASTD) (figure 1), found that in 1996, 84 percent of all training time occurred in instructor-led classroom settings. Seven percent of all training was delivered through self-paced instruction, 6 percent through computer-based training, and 3 percent "other."

The percentage of companies that use a variety of instructional media is summarized in figure 2. Only a tiny fraction of companies (less than 3 percent) report using either the Internet or intranet as a vehicle for delivering training (see figure 2).

Figure 2.—Percent of companies using instructional media

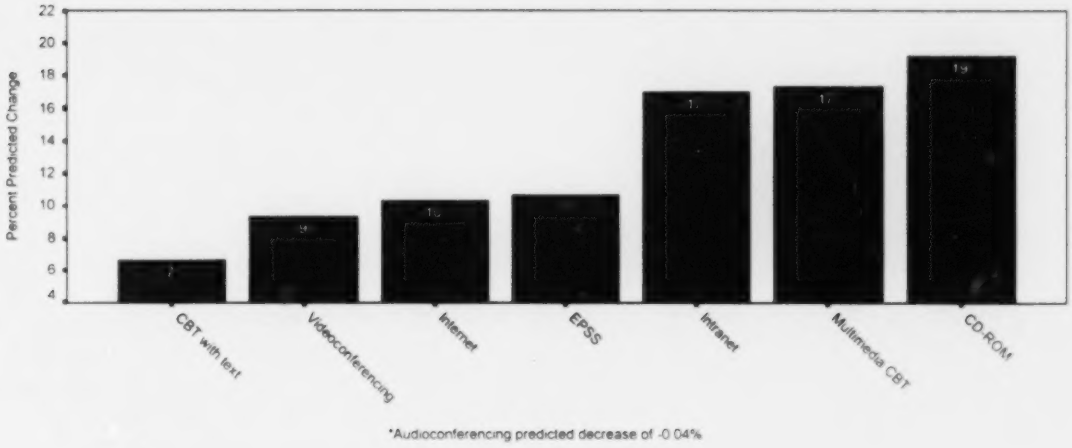


Source: ASTD's Human Performance Practices Report.

Large firms are significantly more likely to rely on computer-based training than are smaller firms. But a more important determinant of firms' choice of the systems they use to deliver training is a variety of innovative training and human resource practices; the more innovative practices a firm uses, the more likely it is to rely heavily on alternatives to traditional classroom training.

Figure 3 summarizes how survey respondents answered the question "How will your organization's total training time delivered by the following technologies change from 1996 to 2000?" (See figure below)

Figure 3.— Predicted increase in media*



Source: ASTD's 1997 Human Performance Practices Report.

Putting the results of figures 2 and 3 together suggests that the increase in the use of electronic technologies for delivering workplace training will be modest over the next 3 years. (Even though some of the predicted increases in percentages are fairly large, the total change is predicted to be

small because the current usage is so small.) It remains to be seen, of course, whether or not these predictions will become reality.

The limited time-series evidence available on employers' use of electronic learning technologies to deliver education and training to their workers suggests that change (at least in the recent past) has not been as sweeping as one might believe from reading the popular press. ASTD has been collecting data from a group of large (primarily *Fortune 500*) firms over the past few years. In 1994, this group of firms delivered 78 percent of all their training and education via traditional classroom training. In 1995, this amount declined to 69 percent, but in 1996 remained virtually unchanged at 70 percent (table 6).

Table 6.—Delivery systems, by percent of training time: 1994–1996

Delivery System	Percent Reported 1994	Percent Reported 1995	Percent Reported 1996
Classroom (instructor-led lecture)	76.4	68.9	70.0
Advanced technology/interactive classroom	4.2	5.5	7.2
Televised electronic distance learning	1.9	2.6	2.7
Computer-based training (CBT)	5.2	7.3	6.0
Interactive/multimedia CBT	3.1	3.7	3.5
Internet/network-based electronic distance learning	.4	1.7	2.5
EPSS	1.1	1.4	1.1
Other self-paced instruction	7.4	7.9	6.9
Other	.5	.8	1.1

Source: ASTD Benchmarking Forum Report.

What can be said with certainty at this point is that the vast majority of employer-provided training is currently delivered via traditional classroom training. The use of computer-based technology is rising, albeit slowly. CBT and distance learning still represent a minor weapon in the training arsenal. Only a tiny fraction of training is delivered via the Internet or intranets, although its rate of growth is impressive (more than quadrupling in 2 years from a base of 0.4 percent in 1994). Although employers are not predicting sweeping change in the short term, over the long term it is possible that we will witness a significant change in the relative balance between computer-based, distance education and classroom instruction.

What the Stock Market Is Telling Us[10]

Wall Street, however, appears to be betting that sweeping changes in the delivery of education and training is, indeed, on the horizon. The owners of a number of specialized training firms have recently made their fortunes by taking their previously private firms public. These initial public offerings are both capitalizing on and fueling the growth of technology-based education and training companies.

Computer Learning Centers, for example, is taking advantage of the available opportunities in the corporate world. It has recently spun off a new division, Advantec Institute, which offers specialized computer classes geared toward employers' interests. Based on the positive response to Advantec thus far,

and the realization that the demand for these training services is greater than the supply, Computer Learning Centers management anticipates that the firm will continue its expansion into the domain of corporate training, particularly in the area of providing customized training packages for companies.

Like Computer Learning Centers, other education and training companies are emerging in corporate markets, and in doing so, are capturing the interest of Wall Street. CBT Systems, Learning Tree International, National Education Corporation, and Westcott communications, among others, have received heightened attention from business investors after recently making public stock offerings.

Smith Barney now advises its clients that "the growing importance of intellectual capital" suggests that a well-balanced portfolio should include investments in the emerging sector of publicly traded education and training providers. Smith Barney segments its coverage of this sector into three groups: (1) educational management organizations, (2) training and development providers, and (3) instructional media companies. With regard to the latter two, Smith Barney bases its advice to investors on what it sees as six big drivers:

- the evolution from manufacturing-based to knowledge-based economy,
- the ubiquitous nature of technology,
- changes in the workplace,
- the advance of communications technology,
- the trend toward outsourcing, and
- the advent of a global economy.

In a presentation at the annual conference of the Instructional Systems Association in March 1997, Charles Hall (Smith Barney's director, Education Group) cited evidence that over the past 2 years, a composite of education and training stocks had appreciated in value at more than twice the rate of S&P industrials.

Nor is Smith Barney alone in its interest in the education and training sector. Goldman Sachs, Montgomery Securities, and Piper Jaffrey have also developed education and training investment lines, and others are poised to enter the market. Warren Buffett, a renowned investor, has taken an active interest in the for-profit training and education industry by buying FlightSafety International, Inc., one of the largest training companies in the world. Michael Milken has invested $125 million of his own money in Knowledge Universe, a training and consulting company which, by year end, is expected to reach $1 billion in sales.

It appears that the investment community has discovered the dawn of the age of knowledge, and subsequently recognized the significance of the training and development industry. These companies' stocks are selling for 30 to 50 times their expected yearly earnings per share, a phenomenon that also characterizes the behavior of technology stocks.

Wall Street, of course, has been known to make bad bets. Only time will tell if this is one of them. But the interest that the investment community has begun to show in the education and training sector, nonetheless, suggests an underlying emerging trend.

If Wall Street is right, then the need that companies have to assess competencies without credentials will only continue to grow as more and more education and training is provided through nontraditional, uncertified methods. Indeed, in private conversations with Wall Street research analysts in the education

and training sector, company representatives concede that the absence of systems for assessing the value of education and training delivered through nontraditional means could well impede the growth of this emerging sector.

If, however, Wall Street is wrong, then not only may this sector fail to grow as quickly as many expect, it could disappear entirely from the horizon. It is certainly possible that a good deal of the media attention being paid to distance learning is fueled by Wall Street's current interest. Should profits in this sector fail to realize Wall Street's expectations for them, then interest in this sector could dissipate quickly. Only time will tell.

Summary and Conclusions

By all accounts, the importance of human capital to our individual and collective well-being will continue to grow into the foreseeable future. The threefold increase between 1981 and 1995 in the percentage of workers who reported that they received formal, employer-provided training speaks to the increasing significance of human capital within the world of work.

Given its increasing centrality to corporate profitability, it is predictable that the task of producing and enhancing human capital will increasingly occur outside traditional classroom settings. Community colleges, universities, and for-profit education and training providers are increasingly in the business of providing education and training to corporate America. By facilitating high-quality, cost-effective delivery of education and training, advances in technology could enable these opportunities to be made much more widely available than has heretofore been possible. To date, however, this possibility has yet to be realized on a broad-based scale. The vast majority of employer-provided training is still delivered through traditional classroom training, and employers are predicting that this will remain the case over the course of the next few years. The stock market, however, is betting that there will be a surge in the electronic delivery of education and training will surge.

If Wall Street is correct, then employers, who report that they are already less than content with their methods of assessing competence, will have to become more creative than in the past. Indeed, analysts on Wall Street already understand that the absence of a broadly accepted system for assessing the extent to which technology-based education and training enhances competence may well inhibit the growth of this sector of the economy.

This is not a task that employers working in isolation will be able to solve optimally. Rather, some collective action will be necessary if the full potential for this market to distribute learning opportunities is to be realized. This suggests a role for public policy.

Moreover, quite apart from the concerns of Wall Street and employers are those of individuals. The labor market analysis summarized herein confirms the by-now well-documented increase in the economic return on education credentials, and suggests that the return on undocumented competence is also on the rise. Consequently, individuals who are seeking to invest in their own education and training have a growing need for information that enables them to make well-informed purchasing decisions with regard to the effectiveness of an increasingly complex array of education and training options. The marketplace will almost surely fail to produce high quality, reliable information of this type—once again suggesting an important role for public policy.

Notes

1. While economists generally agree on the trend in real wages, other observers dispute it. Some have argued that the downward trend in real wages is overstated because the CPI (the Consumer Price Index), used to adjust for inflation, overstates the true rate of inflation. However, to the extent that the CPI has always overstated inflation, this argument does not account for the downturn that took place in 1973. Others argue that the trend in compensation (wages plus fringe benefits) has been less pronounced than the trend in wages (i.e., increases in fringe benefits have partially or totally offset the trend in wages). According to this perspective, wages have merely stagnated, rather than declined.

2. U.S. Government, *Economic Report of the President* (February 1997). As is the case with the wage trend, the low estimates of U.S. productivity growth rates have been challenged by some observers on the grounds that they are mismeasured—understating the true rate of productivity growth. [In fact, because the measurement of inflation and productivity are essentially codetermined, this argument is essentially equivalent to arguing that inflation is overestimated.] While mainstream economists generally agree that productivity growth rates are likely to be underestimated (perhaps by 1 percentage point per year), this mismeasurement cannot explain the post-1973 trends unless: (1) mismeasurement became significantly worse in 1973, and (2) has continued to worsen with the passage of time.

3. Each respondent was asked to assign a weight to these factors so that the factors summed to 100 percent.

4. Comments made at an Aspen Institute Conference on Work and the Future of Society, August 1997.

5. It should be noted that these authors use the term "more-skilled" to mean more highly educated. Autor, Katz, and Kreuger use the term "explains" with caution, noting that their data reveal significant correlations, but cannot prove causality.

6. Computer usage contributes to dispersion in wages across educational groups both because the likelihood of using computers at work increases with education, and because the wage premium to computer usage increases with education. Computer usage contributes to dispersion of wages within educational groups because of the wage premium that accrues to those who use them.

7. Let B=basic selection tools, A=structured applications, I=structured interviews, S=skill tests. Table 5 says that:
   (1) B=36
   (2) B + A + I = 58 ==> A + I =58 - 36 = 22
   (3) B + A + S = 61 ==> A + S = 61 - 36 = 25
   (4) B + I + S = 61 ==> I + S = 61 - 36 = 25
   Equations (3) and (4) imply that A = I, and consequently equation (1) implies that A = 11, which can be used to solve for S = 14 in equation (3).

8. This section draws upon: Laurie J. Bassi, Anne L. Gallagher, and Ed Schroer, *The ASTD Training Data Book (1996);* Laurie J. Bassi, George S. Benson, Mark E. Van Buren, and Rosio Bugarin, *The 1997 Human Performance Practices Report;* Laurie J. Bassi and Scott Cheney, *Benchmarks: Tools for Continuous Improvement* (November 1997).

9. U.S. Department of Labor, Bureau of Labor Statistics Report (December 1996): 13. Recent evidence from the Bureau.

10. This section is taken from: "Trends That Affect Learning and Performance Improvement" (forthcoming), In *Training & Development.*Bassi, Laurie J., Scott Cheney, and Mark Van Buren.

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U.S. Government. *Economic Report of the President*. Washington, DC : U.S. Government Printing Office, February 1997.of Labor Statistics (BLS), however, suggests that the percentage of employees who receive formal education and training at work may be much higher. When asked to record any activity that enabled them to do their jobs better (which BLS then coded as either formal or informal training), a sample of more than 1,000 employees indicated that 70 percent of employees received formal training); American Society for Training and Development (ASTD) *1997 Human Performance Practices* Survey (1997). In a recent survey done by ASTD, employers reported that 58 percent of their workers received formal training in 1996.

High Tech vs. High Touch: The Potential Promise and Probable Limits of Technology-Based Education and Training on Campuses

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From Socrates' lectures in the ancient Greek Symposium to the hundreds of professors who currently use Samuelson's economics textbook in introductory economics classes at campuses across the United States, ample evidence suggests that core pedagogical practices have changed little over time. The basic instructional mode—"the sage on the stage" dominates the collegiate instructional experience today much as it has for centuries.

However, over the past century a steady stream of new technologies have given hope to many both inside and outside of academe that some things just might change. For example, at the turn of the last century, Thomas Edison believed that film might supplant books as the primary resource for instruction by the end of the 1930s. Following the successful use of movies as both propaganda and training tools during the Second World War, film began to migrate into schools, particularly in science education. Television, of course, was the focus of great hopes in the late 1950s and through the 1960s. And over the past three decades, an array of educators have articulated great hopes for the potential role of computers—initially mainframes, then microcomputers in the mid eighties, and now the World Wide Web (WWW).

Indeed, in this context, the broad aspirations for the potential role of computers and information technology across all levels of education were perhaps best articulated 30 years ago by Stanford University's Patrick Suppes, an early innovator in computer-based instruction:

> Both the processing and the uses of information are undergoing an unprecedented technological revolution. Not only are machines now able to deal with many kinds of information at high speed and in large quantities, but it is also possible to manipulate these quantities so as to benefit from them in new ways. This is perhaps nowhere truer than in the field of education. One can predict that in a few more years millions of schoolchildren will have access to what Philip of Macedon's son Alexander enjoyed as a royal prerogative: the services of a tutor as well-informed and as responsive as Aristotle.[1]

Although the language may need some updating, the themes articulated in Suppes' 1967 statement—more powerful and more interactive technologies that will greatly benefit 'teaching, learning, and instruction—remain current and compelling for many in and around higher education. With minor modification, Suppes' 1967 assessment would work well as the 1998 vision statement for any one of the hundreds of large conferences and small seminars on education and technology held annually in the United States and across the globe. It might also work well as the vision statement for a campus technology plan or a policy paper from a federal or state agency.

Yet significant questions remain about the potential promise and probable limits of information technology-based instruction in postsecondary education. Faculty, administrators, technical support personnel, campus trustees and state authorities, as well as corporate patrons of higher education continue to wrestle with an array of issues that cluster into questions about three key issues:

- *content*: how can technology expand access to and improve the quality of information resources that might be incorporated into the teaching, learning, and instruction experience;
- *delivery*: how may technology be used to enhance the delivery of instruction in both traditional and nonraditional contexts, for both traditional and nontraditional learners; and
- *infrastructure*: what kind of infrastructure (hardware, software, networks, technical support, user support, and training) is required to make technology accessible, available, and effective in postsecondary education.

Moreover, against the backdrop of rising expectations and dynamic technologies, some significant questions remain about the potential (and appropriate) role of technology in collegiate teaching, learning, and instruction. Does the broad (or even the focused) application of information technology as content in the syllabus or in the library, and as the delivery vehicle for instruction account for a significant, cost-effective benefit in the educational experience and learning outcomes.

Finally, looming large over the current discussion, institutional planning efforts, and the broad research agenda on the role of Information Technology (IT) in instruction is the shadow of accepted (or tolerated) instructional practices that have adapted to (or survived despite) changing expectations, clientele, and mandates. Ahead for many in the campus community is a contest in which *high touch* ("Mark Hopkins and the log"[2]) competes with *high tech* IT resources (video, television, computers, the Internet and WWW) to be teacher, tutor, testing agent, and information oracle. For some these are inherently conflicting constructs. For others, the coming integration of "high tech" resources with "high touch" instructional practices represents what many faculty and administrators view to be the best hope for revitalizing education and enhancing teaching, learning, and instruction. Still others, both in and out of higher education, view this as a battle for the soul of academe, believing that the growing use of technology reflects both the loss of faculty autonomy and encroaching corporate involvement.[3]

The Instructional Mission

Ultimately, the assessment of the potential role of information technology in the "high touch" vs. "high tech" future of higher education depends on the way technology can serve the mission of higher education. Consequently, perhaps the best way to proceed on this adventure is to map the terrain, focusing on the instructional mission. What are the key components of the instructional mission of higher education? What issues—past, present, and future—define the parameters for the potential role of technology in higher education?

Viewed broadly, but also operationally, the *instructional mission* of higher education involves three primary functions: *content* (what is taught), *context* (the environment that fosters or supports instruction and learning), and *certification* (documenting learning outcomes and competency). (See table 1.)

Content, of course, is the most traditional of the instructional functions: classes, courses, and the curriculum expose students to new information, the structure and validity of data and information in specific disciplines and fields, methodologies linked to the generation of information, and the application of information in specific settings. Traditional assessment models focus on mastery of content: faculty routinely test students on their knowledge of accounting, chemistry, literature, and psychology.

Context reflects the instructional and experiential variables that give colleges and universities their distinctive character. Context can be defined in many ways: the time and place of the learning experience, interaction among students and faculty, and access to campus resources (e.g., libraries and computer networks) that support instruction and learning. Context also reflects the special mission of many institutions: such as technical colleges, church-affiliated institutions, and women's colleges. Indeed, decades of research about the impact of college on the student experience and student outcomes documents the critical effect of *contextual variables* on a range of outcome measures, including learning, intellectual and social development, and satisfaction with the college experience, as well as student retention and degree completion.[4]

Table 1.—The instructional mission of higher education

Content	*Content*	*Certification*
• Information	• Time & Place	• Course
• Structure	• Campus	• Sequencing
• Value	• Learning environment	• Program
• Application	• Resource	• Degree
• Skills	• Acces	• Skills
• Materials	• Socialization	• Licensing
		• Outcomes

The third key instructional function, *certification*, is critical to both students and to society. The structured learning sequence reflected in a course syllabus or a degree program has a certain market value based on content (engineering vs. English, for example), assessment (grades and licensing tests), and program or institutional reputations. Absent certification, potential students might invest their time and educational dollars at Borders, Barnes & Noble, or Crown Books, rather than in college courses. (Indeed, many do!) For the moment, however, neither frequent book buyer cards nor book club memberships provide the outcome measures to test content and assess competency that are required by prospective employers: the certification function remains with colleges and other credible education providers, although not without growing challenges from other agencies and for-profit organizations.

Higher education typically has addressed these three functions concurrently: the classroom and the curriculum focus on content; the campus attempts to foster a learning environment; and the institution (or departments within an institution) certifies educational achievement, specific skills, and professional accomplishment.

Technology makes porous the boundaries that traditionally separate content, context, and certification. Technology brings new, rich resources into the learning experience; it can enhance the interaction *between* instructors and learners, as well as the interaction *among* learners. Also, technology can fundamentally change the way students and institutions approach assessment and certification.

Can technology do all the things that many claim and others suspect? Perhaps, over time. However, the truly compelling, carefully constructed assessments that might document enhanced outcomes and improved academic performance have yet to emerge; to date, much of the research literature reports no (statistically) significant gains.

Assessing the Role of Technology in the Classroom

Does the research literature provide a compelling case for broad investment in computers and information technology?

Currently the research literature offers, at best, a mixed review of often inconclusive results, at least when searching for traditional measures of statistical significance in learning outcomes. Van Dusen's 1997 review notes that it is "important to emphasize the essential neutrality of technological environments with respect to learning." Van Dusen refers to two other major reviews, which concluded that "instructional media (1) were not inherently superior and (2) did not directly influence student achievement.[5]

These two major reviews, separated by a decade that marked the growing use of computers in education, reach similar conclusions. Writing in 1983, Clark offered a "no significant effects" assessment for the impact of instructional media:

> The best evidence is that media are mere vehicles that deliver instruction but do not influence student achievement any more than the truck that delivers our groceries causes change in nutrition.... Only the content of the vehicle can influence achievement.[6]

A decade later, with broader experience using desktop computers, Russell offers a somewhat similar assessment:

> No matter how it is produced, how it is delivered, whether or not it is interactive, low-tech or high-tech, students learn equally well with each technology and learn as well as their on-campus, face-to-face counterparts even though students would rather be on campus with the instructor if that were a real choice.[7]

Yet these studies and others typically focus on comparisons of how well students learn similar materials with and without technology. Much of the academic research fails to look at how technology changes and enhances teaching, learning, and instruction. Indeed, one of the more recent (and highly publicized) studies claiming enhanced learning outcomes because of an IT component suggests that student engagement, rather than the technology component in and of itself, may have been responsible for better academic performance.[8]

But in this context, maybe the key issue is how IT resources change teaching, learning, and instruction, rather than how technology affects specific (and often the lowest common denominator) learning outcomes. Perhaps the best article on this topic, a 1992 paper by Robert Kozma and Jerome Johnston, presents compelling evidence, drawn from a number of disciplines and a variety of campuses, about the role of information technology as a catalyst for or enabler of the qualitative dimensions of the learning experience.[9] Summarized below, Kozma and Johnston identify seven ways that computing and information technology can be used in the transformation of teaching, learning, and the curriculum:

- *From reception to engagement.* "The dominant model of learning in higher education has the student passively absorbing knowledge disseminated by professors and textbooks.... With technology, students are moving away from passive reception of information to the active engagement in the construction of knowledge."

- *From the classroom to the real world.* "Too often students walk out of class ill-equipped to apply their new knowledge to real world situations and contexts. Conversely, too frequently, the classroom examines ideas out of the context of gritty real-world considerations. Technology is breaking down the walls between the classroom and the real world."

- *From text to multiple representations.* "Linguistic expression, whether text or speech, as a reserved place in the academy. Technology expands our ability to express, understand, and use ideas in other symbolic systems."

- *From coverage to mastery.* "Expanding on their classic instructional use, computers can teach and drill students on a variety of rules and concepts essential to performance in an interdisciplinary area."

- *From isolation to interconnection.* "Technology has helped us move from a view of learning as an individual act done in isolation toward learning as a collaborative activity. And we have [also] moved from the consideration of ideas in isolation to an examination of meaning in the context of other ideas."

- *From products to process.* "With technology, we are moving past a concern with the products of academic work to the processes that create knowledge....[Students] learn how to use tools that facilitate the process of scholarship."

- *From mechanics to understanding in the laboratory.* "The scientific laboratory is one of the most expensive instructional areas of the academy. It is costly to maintain the proper equipment and supplies, and to provide supervision to student scientists. It is also a limited learning experience [as] so much time is spent replicating classic experiments that there is little time left to explore alternative hypotheses as real scientists do."[10]

There are many ways that information technology can enhance the undergraduate curriculum and student learning experience. The key issue, as noted by Kozma and Johnson, is the effective use of information technology resources as tools to *support* instruction and learning outcomes, rather than to supplant the traditional faculty role.

In sum, Kozma and Johnson identify technology-based instructional interventions (all of which predate the WWW) thus documenting the successful use of computer software to improve the quality of learning and teaching in each of the categories described above. Indeed, Kozma and Johnson, drawing on their work with the faculty who received national recognition from the EDUCOM/NCRIPTAL Higher Education

Software Awards Program,[11] report that most award winners needed 5 to 7 years to develop their own instructional applications. Students in the classes of these faculty benefited significantly from the faculty effort to develop instructional software. But overall, Kozma and Johnston report minimal dissemination and adoption: beyond the students enrolled in the classes of the courseware developers, comparatively few students, courses, or other institutions ever benefited from that work.

Focus for a moment on just the classes where faculty used the EDUCOM• NCRIPTAL award software to support instruction. Were it possible to accurately calculate or even estimate the increases in student learning linked to these instructional resources, the "productivity gains" for individual students would (probably) produce impressive numbers. Students in these classes were usually not required to pay additional fees or invest much additional time, but they were enabled to learn more—to learn it faster, better, more comprehensively; technology, suggest Kozma and Johnson, enabled these students to become more engaged in the learning experience. In essence, Kozma and Johnson suggest that even in these early efforts, improved outcomes divided by stable costs generated increased productivity.

Why Invest in Information Technology— and Why Now?

If the research is inconclusive, why do campuses continue to invest millions of dollars each year to acquire and support the instructional application of information technology? Although great aspirations play a role, other factors are evident.

The Demographic Factors

Following a 16-year decline, the traditional college-age population in the United States is rising: The size of the U.S. high school graduating class will grow by more than 20 percent between 1994 and 2005, returning to peak levels last seen in 1978. Additionally, more high school graduates are going on to college: In 1995, the percentage of recent high school graduates who entered college a year after receiving a high school diploma approached two-thirds of the U.S. graduating high school class, up from 49.3 percent in 1980. In sum, the enrollment gains ahead are fueled by (a) more college age students and (b) a larger percentage more of these high school graduates going on to higher education.[12]

At the same time, the nontraditional college student cohort in the United States is also increasing, fostered by shifts in the labor market. U.S. Department of Education projections suggest that by 2000, 5 of every 11 college students attending U.S. colleges and universities will be age 25 or older. Concurrently, the number of students aged 35 and older will exceed those who are 18 and 19 years old.[13] Admittedly, the growing adult clientele differs from the traditional student population in significant ways such as enrollment patterns (concentrated in community colleges; part-time enrollment status) and intended majors (occupational and professional programs, as well as short-term training and non-degree programs).

Taken together, these two "customer cadres" could push enrollments in American 2- and 4-year colleges and universities from today's 15 million students toward 20 million by 2010.[14] But the new demand is not likely to be met with any significant increase in the physical capacity of higher education (i.e., new classrooms and new campuses). Given the rising competition for their social-service dollars, few states currently seem inclined to fund construction of new college campuses. Consequently, the demographic factors alone point to significant opportunities for using information technology (a) as a vehicle to deliver instruction and (b) as a resource to serve the growing demand in the absence of any significant expansion in the "mortar and brick" capacity of college campuses and classrooms.[15]

The Pressure for Productivity

Rising college costs, as reflected in dramatic increases in college tuition over the past decade, have helped focus significant attention on the issue of productivity in higher education. Additionally, rising enrollments, increased demand for training, no significant gain in physical plant capacity, and increased competition for social services dollars all contribute to an expanded (and increasingly heated) discussion about productivity.

Not surprisingly, the January 1998 report of the National Commission on the Cost of Higher Education identifies productivity as a top priority for American colleges and universities. While not explicitly citing technology as a potential solution for some of the productivity challenges confronting higher education, the language of the Commission's recommendations points in that direction:

> The Commission recommends the creation of a national effort led by institutions of higher education, the philanthropic community, and others to study and consider alternative approaches to collegiate instruction which might improve productivity and efficiency. The Commission believes significant gains in productivity and efficiency can be made through the basic way institutions deliver most instruction, (i.e., faculty members meeting with groups of students at regularly scheduled times and places). It also believes that alternative approaches to collegiate instruction deserve further study. Such a study should consider ways to focus on the results of student learning regardless of time spent in the traditional classroom setting.[16]

What role does technology play in the discussion of productivity and college costs? Reduced to the core issue, the "technology yields instructional productivity" advocates are eager to demonstrate that information technology will (a) allow the same number of faculty to "teach" more students at the current (or at an enhanced) level of learning or (b) allow campuses to serve the same number of students with fewer faculty and with no loss in learning (either measured by what is learned or by the number of students who learn it).

Clearly, technology has brought both enhanced productivity and reduced costs to some parts of the academic enterprise. Like many corporations, colleges and universities routinely and effectively use technology in many administrative areas. As in the corporate domain, computers have improved productivity related to a wide range of data management and transaction-processing activities including personnel files, course schedules, library catalogs, accounting and budgeting, student transcripts, and admissions information. Growing numbers of campuses are placing more information (e.g., course catalogs, student handbooks, faculty/employee handbooks) on their campus WWW sites. Many are also using the WWW as part of their marketing strategy to reach prospective students and encouraging applicants to complete application materials online via the institution's WWW page.[17]

Moreover, in some parts of the faculty domain, technology has truly helped to increase productivity and reduce operating costs. For example, a generation of faculty has come into academic positions with little or no secretarial assistance from their departments or institutions: they routinely use a computer to prepare their own class materials, course syllabi, conference papers, grant proposals, manuscripts, and other documents. However, more than a dozen years into the much-discussed "computer revolution in higher education," relatively few in the campus community could successfully argue that postsecondary education has experienced any real gains in *instructional* productivity linked specifically to the introduction of computers and other kinds of information technology resources. In that realm, as ever, what still lingers is the "promise" of technology.

Indeed, there is ample and in some ways distressing evidence that traditional cost-benefit analysis and cost accounting models for instructional activities are difficult if not impossible for most institutions. Even if individual institutions experience some kinds of productivity gains (i.e., reduced costs) that appear directly linked to an IT intervention, it's not clear that colleges or individual academic programs can accurately or successfully measure these gains in a manner similar to the way that the corporate sector attempts to calculate a return on investment (ROI) value on investments in new technology.

Moreover, economist Howard Bowen's widely cited but too-often unheeded work on the costs of higher education provides compelling evidence that colleges and universities do not allocate resources in a rational manner. Bowen's analysis documented wide variations in instructional costs across similar types of institutions, as measured by mission, status, and clientele. In the end, Bowen noted, colleges and universities accumulate all the revenue they can and then spend all they accumulate.[18] Such ingrained behaviors, coupled with a centuries old tradition of "high touch" instructional models, provide few incentives for institutions (or individuals employed by these institutions) to search for methods that might enhance instructional productivity, even in periods of financial duress or technological innovation.

Other Key Factors

Beyond demography and productivity, three additional factors push institutions in the United States and elsewhere to invest in a wide range of IT resources. These factors can be clustered into three categories:

- *The coming ubiquity of information technology.* Upwards of 40 percent of U.S. households now have at least one computer, up from 34 percent in 1996 and 27 percent in 1994.[19] Across the U.S. economy, and in large parts of Europe, Asia, and sectors of the developing world, technology seems ubiquitous, even if it is not. The growth in households ownership in the United States has occurred among middle-income households earning from $40,000 to 70,000, the "sweet spot" of the U.S. consumer market that is very attractive to technology firms.

  Growing numbers of college-bound students come to campus with computer skills and technology expectations. In Fall 1995, more than one-half (55 percent) of all first-time, full-time college freshmen in U.S. colleges and universities reported having had, at a minimum, one-half year of "computer science" or some form of formal computing or technology instruction while in high school.[20] These students, as well as their older counterparts who are likely to have had some experience with computers because of their work environments, now come into campus expecting to *learn with* computers and information technology, not just to acquire computer and technology skills.

  Consequently, colleges and universities must invest in computers and information technology if only to tell their potential clientele that the institution provides the IT resources increasingly available elsewhere, meaning in homes, high schools, the workplace, and at competing institutions.

- *Curriculum enhancement.* As noted earlier, education has long been drawn to the potential that technology might bring to education—both as a source of content and also as a vehicle for delivering instruction.

  Indeed, across the collegiate curriculum—from astronomy and accounting to zoology and everywhere in between—various kinds of information technology resources, including but not limited to the WWW, hold the potential for providing rich, engaging resources for students. Images, statistical data, library materials, and more are all part of the potential mix that excites scholars and academic evangelists.

- *Labor market expectations.* Stated simply, technology skills will be essential in the increasingly competitive and global labor market of the 21st century. Postsecondary institutions are engaged in a kind of educational malpractice if they fail to provide students with basic technology training as part of their postsecondary experience.

Distance Education

Finally, any discussion about technology in postsecondary education would be incomplete without citing the growing demand for distance education. Here demography and labor market issues converge: what drives the market for distance learning is growing numbers of (working) adults eager for various kinds of postsecondary experiences ranging from short-cycle certificates to complete degrees.

In this rapidly growing segment of the higher education market, traditional notions of *access* to postsecondary education take on new meaning, shifting from policy discussions about college costs and the racial/ethnic/income profile of students to operational planning focused on leased classrooms, part-time faculty, employer reimbursement policies, program certification, and distribution of "content and instruction" via various "enabling technologies" such as phone, video, and the Internet.

Clearly distance education is a booming business. The University of Phoenix (www.uophx.edu), a fully accredited, for-profit, postsecondary enterprise, proudly boasts that it is now the second largest private college or university in the United States.[21] Chartered in 1978 and currently enrolling more than 42,000 students, Phoenix has been an aggressive competitor in both classroom- and cyberspaced-based distance education programs targeting adult learners. National Technological University has a well-deserved international reputation for providing timely, high-tech telecourses in engineering and computer science. Mind Extension University (now the Knowledge Network, a division of Jones International) distributes college courses from a growing array of institutions via cable TV networks.

But the increasingly technology-driven distance education movement extends well beyond the University of Phoenix, NTU, and Jones International, or the dozens of colleges and universities that broadcast telecourses on local cable systems. Ten minutes on a Web search engine at Yahoo!, Lycos, or Alta Vista yields literally hundreds of academic and commercial URLs for distance education programs and services from traditional institutions as well as new providers. New "digital universities" created by for-profit organizations (e.g., McGraw-Hill University; Ziff Davis University, University On-Line, among others) offer low-cost, WWW-based, short-cycle, asynchronous training, targeting a wide audience of working adults seeking to upgrade their IT skills.

Perhaps the most ambitious academic or commercial venture into distance education is Western Governors' University (WGU), a cooperative effort among more than a dozen western states. Start-up costs are estimated at $6–10 million. Charter documents, available at the WGU's Web site (www.westgov.org), outline a technology-driven "regional virtual university through which instruction will be accessible at the learner's convenience via advanced technology. This learning can be certified to the satisfaction of both employers and academic institutions through the assessment of competencies, and states and the private sector will share in the development and use of instructional materials." An ambitious mission, fueled by great aspirations.

But it appears that few in academe understand that the technology factors involved in distance education are different than the factors affecting more traditional models of instruction. Course content, not the classroom experience, drives distance education.

Indeed, with or without a technology component, distance education programs often are more responsive to market needs and student demands than most parts of the academic enterprise. As shown in table 2, market forces affect just about all aspects of distance education initiatives in ways that differ dramatically from the impact of market issues on more traditional academic programs.

Table 2.—The market role in traditional and distance education programs

Aspect	Traditional academic Programs	Distance Education
Mission	Mandated by trustees or state authorities	Determined by market
Curriculum	Faculty-centered	Content-centered
Credibility	Institutional reputation	Market performance of students
Financing Model	Operating subsidy	Profit and loss Analysis

Perhaps like the California forty-niners eager to stake their claims for gold at Sutter's Mill almost 150 years ago, growing numbers of colleges and academic programs are rushing forward with little real planning and without a good map of the terrain. Certain that there is "gold" in distance education, many campus and public officials believe that institutions absolutely must "be there" ahead of (or at least "shoulder-to-shoulder" with) the competition—other colleges and universities as well as commercial ventures and in-house corporate training centers. Having spent some time wandering the WWW or captive to Mind Extension University's (now the Knowledge Network's) cable offerings in hotel rooms while they travel, administrators and program coordinators are often surprisingly confident that instructional technologies (cable, video, and the Internet, among others) will provide a low-cost, high-revenue distribution channel. Program officials also are often highly confident about the likely success of their efforts, even as they happily discuss the core problems that will undermine competitors' offerings. Technology is an increasingly important component of the overall distance learning plan, a core resource for both content and distribution that promises to make programs both viable and accessible.

While drawn to the light (and to the money), it is likely that many will be burned by the heat in the forge. Some institutions and programs have built their instructional development and delivery models on the premise of underutilized capacity and leveraged resources: the underlying assumption is that technology resources and instructional personnel involve marginal rather than core costs. Yet there are limits to leverage in every market and in every enterprise.

These issues—demography, productivity, the new ubiquity of IT, curriculum enhancement, and labor market expectations—only set the *context* for investments involving, and expectations about, the potential role of IT in collegiate instruction. Other questions remain.

The Costs of Technology

Ten minutes spent surfing cable TV channels or well-developed corporate WWW sites quickly bring into focus many of the content and delivery issues affecting the role of technology in postsecondary education: can a campus-developed telecourse or WWW-based learning module on art history, astronomy,

biology, history, or physics compete with the content, quality, and production values routinely found in the programs broadcast each week on the History Channel, the Discovery Channel, or the PBS Nova series? Can "campus products" successfully compete with the computer-based instructional tools and WWW-based, content-rich, digital resources that commercial developers—both small start-ups and large corporations—bring to the postsecondary market?

Indeed, many institutional officials have simply opted to avoid (or ignore) the core financial question: What are the *real* costs of content and supporting instructional resources in a technology-enhanced world of postsecondary education: $2 for a digitized version of a book chapter or scholarly article? $20–$50 dollars to have a work-study student or a media specialist videotape a faculty lecture? $20–$200 per hour for faculty time? $200–$2,000 for 60 minutes of an unedited classroom video? $20,000 for 30 minutes of a production-quality lecture? $100K for 60 minutes of commercial-quality video? $200–$400K for "complete" IT-based instructional modules?

Compare these costs—real costs—against the way many campuses and academic programs build financial models for their efforts to bring IT into instruction (and, more recently, distance education): supplemental pay for faculty to bring a course and syllabus from the classroom into an on-campus video studio, work-study wages for undergraduates to write computer code and to develop multimedia resources. Extended hours for graduate students, who are committed to an academic apprenticeship, to help senior faculty identify supporting materials for the transition from real-time classrooms to online or video environments. Unbilled hours committed by curriculum design specialists and technology support personnel. "Free" (or significantly subsidized) access to technology resources such as desktop computers, networks, servers, software, and more.

This is familiar if often forgotten terrain. Higher education's first wave of desktop computing, in the mid-1980s, was accompanied by some ambitious faculty efforts to create "courseware" intended to supplement and enhance instruction. Some of these initial efforts were little more than "widget" templates for spreadsheets; others were more sophisticated endeavors. The expanding use of technology by students and faculty between 1984 and 1994, coupled with the lure of (and hype surrounding) "multimedia," subsequently tempted still more faculty to try their hand at developing instructional materials. Often these initial campus efforts were supported by foundations, technology firms, or small, seed-money institutional grants; others were fueled only by the good intentions and instructional aspirations of individual faculty drawn to the potential of instructional technology.

By 1996, the exploding use of the Internet and the World WideWeb provided yet another catalyst for faculty, institutions, and instructional publishers to revisit the role of technology in classroom and distance education. The cross-platform ubiquity of the WWW in the campus community, not bounded by IBM-compatibles, WinTel systems, Macintosh computers, or Unix workstations has helped to resolve some earlier infrastructure and compatibility problems linked to hardware, software, and access. The explosive growth of potentially useful content on the WWW, coupled with new, easier to use development tools, has lured some faculty to examine again the role of information technology in their instructional activities and scholarly work.

But the return on the dollars and faculty time invested in instructional development has been mixed: the campus experience of the past decade reveals that successful instructional development typically depends on an interdisciplinary team of content specialists, instructional designers, and codewriters. The late-night efforts of "early adopter" faculty to create "courseware," let alone complete instructional modules, often

have not been successful: many efforts underestimated the challenge of developing instructional materials, as well as the real financial costs and accompanying time commitments. Additionally, faculty developers (and their student assistants/codewriters) frequently encountered some variation of the 80/20 rule: the last 20 percent of the development/ software task often requires 80 percent of the effort. Finally, successful faculty developers and their student assistants encountered an often unexpected problem: updating their products with new content, an enhanced interface, and more features, they quickly learned that software and digital content, unlike the published paper, has a life after the initial release.

The all-too-common campus investment strategy in technology-based courses—small seed money grants of $5,000 or $10,000 clearly helps to fuel individual aspirations. But the accompanying great expectations for significant (if supplemental) classroom modules or distance education courses typically require significantly more money.

But what about the campus project that readily consumes $50,000, or $100,000, or maybe even $500,000? Probe beneath the surface at some campuses that invested heavily in serious efforts to develop courseware and multimedia content: and it is often easy to find the stories of well-conceived development projects that were a sponge for institutional and foundation dollars. Although fueled by good intentions and great aspirations, many (perhaps most?) of these efforts unfortunately failed to produce an instructionally useful or commercially viable product.

In contrast to campus models of seed grants and contributed (or uncharged) time, major college market publishers (e.g., Addison Wesley Longman, McGraw-Hill, Simon & Schuster, John Wiley, among others) have spent millions over the past decade developing video and digital ancillaries linked to their textbook products: here too the return on investment—as measured by sales revenue and educational impacts—has been modest at best. Indeed, many college publishers acknowledge in private conversations that their investments are often a defensive posture made to protect the position of a leading textbook.

Beyond the traditional publishers, new kinds of IT development firms are assessing the campus market carefully. Perhaps the best-funded of these new entries is Academic Systems in Mountain View, CA (*www.academic.com*). Currently focused on developing "technology-mediated, multimedia learning resources" for remedial and entry-level courses in math and English, Academic Systems has secured investment from some of the top U.S. venture capital technology firms and companies. Similarly, other established technology firms are looking at the campus market carefully. For example, Lotus and IBM are promoting the Notes/Domino-based Lotus Learning Center as a comprehensive solution for some kinds of IT-based instruction.

It is too early to assess the initial success of these corporate efforts—both as instructional solutions and as software start-ups. For traditional college publishers, much of the IT investment has been a "loss-leader" intended to promote traditional textbooks. For the early venture capital (vc)-funded start-ups targeting the campus market, there is too little product and too little history to assess the chances (or impact) of particular products, strategies, or firms. Additionally, despite some claims for significant success in enhancing learning outcomes and reducing instructional costs, as yet there is too little independent research verifying the advertised results of the products emerging from many of the commercial firms targeting the campus market.

Seen in this context, and looking broadly across campus and corporate boundaries, instructional development for the campus market begins to look like a venture capital business—generally acknowledged as risky business. Venture capital, like a campus seed grant, seeks the innovative idea and individual. But even with diligence, venture capitalists know that at best only 1 in 10 (or fewer) investments will be

successful. For every VC-financed startup that turns into an Apple, Compaq, Netscape, or Yahoo!, literally hundreds of small, venture-financed companies created by smart people with compelling ideas never survive. Most will burn through the initial money and crash; a few will break even, while less than 10 percent (or perhaps even 5 percent) survive, let alone thrive.[22]

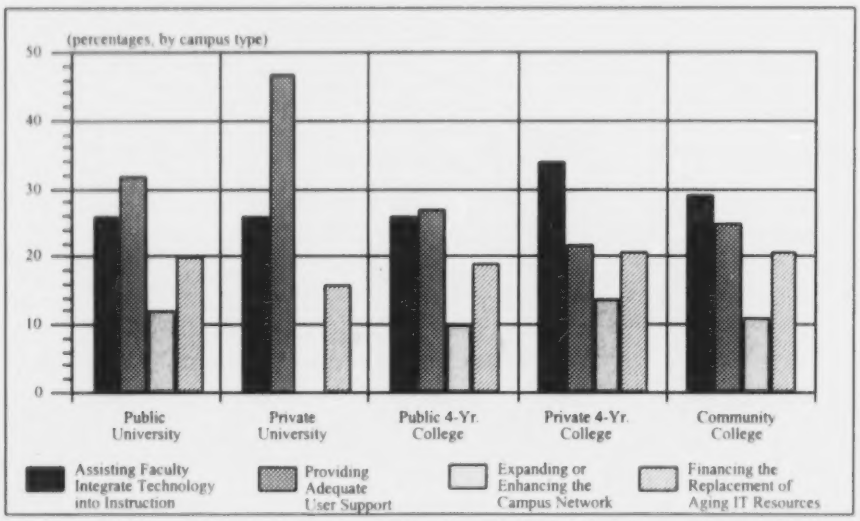
Although the sums are small compared to the money involved in venture capital, the campus experience over the past decade reveals that the dollars can be daunting, the return on investment highly uncertain. Consequently, growing numbers of institutions are looking to external sources (textbook publishers, curriculum entrepreneurs) to provide technology-based instructional modules, rather than invest in faculty efforts.

Infrastructure and Innovation

Technology represents an innovation in higher education. Indeed, technology presents several categories of innovations involving pedagogy and content. The literature on the diffusion of innovations suggests that in many instances, infrastructure fosters innovation and the integration of innovation into daily practice.[23] That seems to be the case in academe.

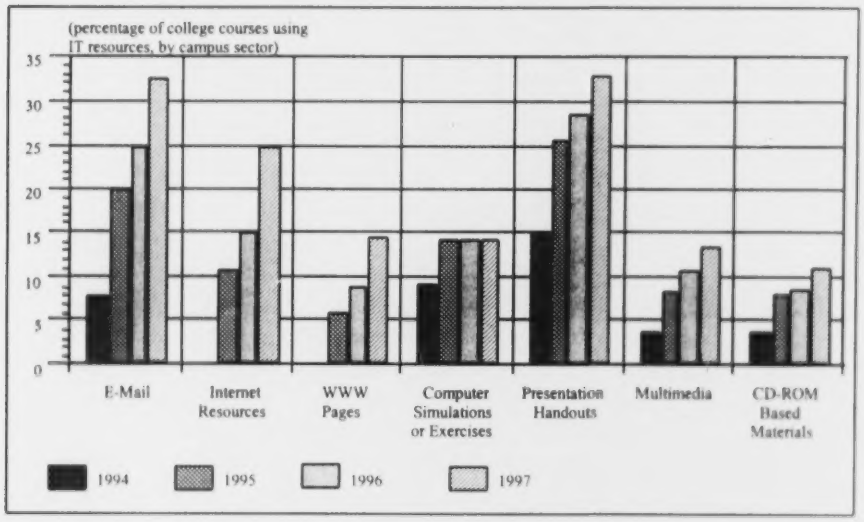
Viewed in this context, the slow integration of technology resources (both digital content and digital delivery) represents a significant innovation for higher education. Most faculty have had little training on the effective use of IT as a scholarly resource or instructional tool. Beyond word-processing, e-mail, and some use of the WWW, the inferential and anecdotal data suggest still low, if admittedly growing rates of technology integration. Indeed, technology integration into instruction looms as the "single most important issue confronting institutional IT efforts over the next 2–3 years" (see figure 1).[24]

Figure 1.—Key issues for information technology in traditonal postsecondary education



As for instructional integration, 1997 Campus Computing Report reveals that while rising in recent years, the percentage of classes using various kinds of IT resources remains low, generally below 25 percent. E-mail, word processing, and presentation handouts (e.g., PowerPoint or Persuasion) are the most commonly used IT resources; in contrast, IT interventions that require infrastructure, training, and money such as simulations and commercial courseware are used in less than 10 percent of all college classes (figure 2).

Figure 2.—Percent of college courses using IT resources, 1994–97



These data, and others from the Campus Computing Project, ultimately reinforce the perspective that *infrastructure* fosters instructional innovation and, subsequently, the instructional integration of information technology. As a resource to supplement instruction (e.g., resources on the WWW) or to supplant the traditional role of teacher and book and become the primary means of both content delivery and assessment, the successful integration and adaptation of IT as an instructional resource will depend on the IT infrastructure on campus, and availablility to the individual learner either on or off-campus.

What are key components of an effective IT infrastructure in higher education? Some elements are easy to identify: hardware and software, campus networks, student and faculty access to e-mail; the Internet, the WWW and digital libraries. These top the priorities at most institutions, both elite research universities as well as small community colleges.

Classroom and campus access to IT resources also are critical issues. Few college classrooms have Internet connections; most do not have the kind of computerized projection resources commonly found in bowling alleys across the United States.

But the experience of the past decade points to other key elements. Training is critical: as noted, most faculty have had little training on how to make effective use of IT resources in their instructional and scholarly work. Moreover, the few faculty who invest time, effort, and energy into attempting to develop IT

resources to support their classroom work seldom receive any reward or recognition for their efforts. Indeed, too often they are implicitly penalized for their "adventures in instructional technology" when it comes time for review and promotion decisions.[25] Consequently, within academe, recognition and reward are also critical barriers to the broader experimentation with and wider use of IT resources in instruction and learning.

As for the commercial efforts to bring IT to the classroom and learning experience, here too much also depends on faculty. As noted, training and user support are critical issues. But so, too, will be faculty acceptance of IT resources and interventions. Many faculty who see potential in IT as an instructional resource nonetheless may view administrative efforts (or public mandates) to transfer some instructional tasks from teacher to technology as part of "management's" efforts to reduce costs absent any concern for broader issues of the learning context or student-faculty interaction. Others may fear new work rules that affect ways institutions "count" enrollment and determine teaching loads in traditional and online classes (e.g., three classes of thirty vs. one cyberspaced class with some seventy students at remote location).[26]

Beyond issues of content and (the learning) context, there is the very major issue of certification. Just as employers look to institutions for certification of student performance and mastery, so too do professors look closely at one another on the issue of "certification:" "will the students from my class do well in the one that follows?" "The students who took the intro course last fall were not well prepared for the spring term materials;" "Students from that undergraduate program do well in our graduate program." Faculty confidence in IT-based instruction and certification will also (ultimately) affect confidence in these resources and acceptance in both academe and the labor market.

To date, however, certification remains a very weak link in IT-based instruction. Many faculty will provide testimony about the role of technology in enhancing the content in their classrooms or the context of the learning experience. However, few have direct experience developing or using technology resources for assessment and certification. Ample prior experience indicates that the postsecondary market demands much more than digitized multiple-choice tests that are easily imbedded as review modules in IT-based instruction. Indeed, conversations with faculty and administrators about key challenges in this area often move quickly to assessment issues: while many will acknowledge the potential of IT-based resources to deliver and enhance instruction, few feel that current IT-based assessment tools begin to approach the sophistication and complexity reflected in the tests and exams that are a common part of the (traditional) college course experience.

Here, perhaps, many will watch closely the competency-based efforts of Western Governors' University. Both academic and corporate observers will monitor carefully WGU's efforts to develop new kinds of IT-based assessment modules and the accompanying response of both institutions and employers to the first "graduates" of WGU's programs. For WGU and other IT-based virtual programs and institutions (both for profit and non-profit), the true market test is simple: the market test is not how well (very) good students can learn under any circumstances, but if the underlying technology that will permeate WGU's instructional delivery and assessment strategies will find acceptance among a broad student clientele and support among a wide range of employers. Indeed, the market test focuses on the "value added" by the WGU instructional and learning experience.

Finally, instructional integration of IT must address the payment issue: who pays for these resources? Are these institutional expenditures, similar to hardware, software, and personnel? Will these costs be passed through to students, who will buy IT modules the way they currently purchase textbooks? These

issues are also important in the broad discussion, especially as some of the commercial offerings involve significant per-student costs, perhaps $100 per student per instructional module.

Looking Ahead

It has been 30 years since Patrick Suppes articulated his vision statement for the role of computers and technology in education. Perhaps we may (again) return to Suppe's vision 30 years from now to assess how far we have come and the distance yet to go. While we will have made significant gains by 2028 (as we have since 1968), we in academe (and elsewhere) will still likely be engaged in continuing research and heated debate about "high touch" ("Mark Hopkins and the log") vs. "high tech" (computer/IT based instruction) as the appropriate link to the past, and also as a path to the future of technology.

Notes

1. Suppes, Patrick. The Role of Computers in Education. *Scientific American* (October 1967).

2. Defending Williams College from the attacks of some unhappy alumni more than a century ago, Wiliams graduate (and future U.S. President) James Garfield, is reported to have responded that "the ideal college is Mark Hopkins [William's president] on one end of a log and a student on the other." Rudolph, Frederick, *The American College and University: A History* (Athens, GA, Univ. of Georgia Press, 1990), p. 243.

3. Historian David F. Noble of York University (Canada), argues that "in this new age of higher education, the lines have already been drawn in the struggle .... On one side [are the] university administrators and their myriad commercial partners, on the other those who constitute the core relation of education: students and faculty. Noble, David F., "Digital Diploma Mills: The Automation of Higher Education." *First Monday* , an Internet journal, www.firstmonday.dk/issue3_1/index.html; (January 1998).

4. See, for example, Astin, A. W., *Four Critical Years* (San Francisco: Jossey-Bass, 1978), and *What Matters in College* (San Francisco: Jossey-Bass, 1993). See also Pascarella, E. T. and Terenzini, P. T., *How College Affects Students* (San Francisco: Jossey-Bass, 1991).

5. Van Dusen, Gerald, *The Virtual Campus: Technology and Reform in Higher Education.* ASHE-ERIC Higher Education Report, Volume 25, No. 5. (Washington, DC: The George Washington University), 1997, p. 38.

6. Clark, Richard, "Reconsidering Research on Learning from Media." *Review of Educational Research* (53, 4), (1983): 445.

7. Russell, Thomas L. "The 'No Significant Difference' Phenomenon as Reported in Research Reports, Summaries, and Papers. (Raleigh: North Carolina State University Office of Instructional Telecommunications), 1993, p. 2.

8. See, for example, McCullum, Kelly, "In Test, Students Taught On-Line Outdo Those Taught in Class." *The Chronicle of Higher Education*, (12 February 1997), A-23). At California State University Northridge, a political science professor randomly assigned students to two sections of his quantitative methods class: one section was classroom-based, the second "cyber-spaced," and conducted over the Internet and WWW. Students in the "wired" section outperformed students in the traditional classroom section by roughly 20 percent on both the mid-term and final exams. The professor who offered the class and studied the academic performance of both groups concluded that the differential was due, in part, to the fact that "students formed study groups to compensate for their lack of face-to-face contact with a professor. [The] collaboration ...helped the students to learn more effectively."

9. Robert Kozma and Jerome Johnston, "The Computer Revolution Comes to the Classroom." *Change* (January-February) 1991. Their *Change* paper summarizes a major research report prepared for the U.S. Department of Education in 1991.

10. Kozma and Johnston, pp. 16–18.

11. Begun in the mid-1980s, the EDUCOM-NCRIPTAL program was a national initiative intended to encourage faculty to develop instructional software. Winners received cash prizes for their work. The 5 year evaluation study by Kozma and Johnson of the National Center for the Research in Postsecondary Teaching and Learning at the University of Michigan was one of the largest evaluation projects to assess the impact of these efforts on student learning, IT integration, and curriculum change.

12. Data from the National Center for Education Statistics (NCES) reveal that the number of high school graduates in the United States increased from 2.2 million to 2.6 million between 1991 and 1996, below the peak of 3.16 million in 1978, but clearing rising nonetheless. Concurrently, between 1991 and 1996, the percentage of high school graduates entering college within a year of high school graduation rose from 62.4 percent to 65.0 percent, up from 50.1 percent in 1978. National Center for Education Statistics, *Digest of Education Statistics, 1997*, Table 184. (Washington, DC: Government Printing Office, 1997). The annual *Digest of Education Statistics* is also available online at: www.ed.gov/nces.

13. Fall 1995 data from NCES reveal that enrollments of individuals aged 19 and under totaled 3.17 million (22.2 percent of total headcount enrollment.) In contrast, enrollment of individuals aged 30 and over totaled 4.091 million students (28.7 pct of 1995 headcount enrollment). *Digest of Education Statistics, 1997*, Table 176.

14. NCES projections point to total (headcount) enrollments of 16.1 million by 2007 (*Digest of Education Statistics, 1997*, Table 174). However, the growing numbers of both traditional students and part-time adults could push total enrollments in accredited postsecondary institutions towards 20 million by 2010, a scenario first proposed by Howard Bowen in 1974 (Bowen, Howard R., "Higher Education: A Growth Industry?" *Educational Record*, 55, [Summer 1974 –147–58]

15. Demographic factors are far more pressing in developing nations. For example, in his 1996 book, *MegaUniversities and Knowledge Media* (London: Kogan Page) Sir John Daniel, formerly vice rector of Britain's Open University, notes that "already 50 percent of the world's population is less than 20 years old. In developing countries, the proportion is much higher, rising to 70 percent in Palestine and 80 percent in South Africa" (p. 5). Although demographic factors may differ in individual nations, the competition for funds to support social service and infrastructure investments, including education, is keen in both developed and developing nations.

16. National Commission on the Costs of Higher Education, *Straight Talk About College Costs and Prices. Final Report*, January 28, 1998, GPO, Washington, DC.

17. Green, Kenneth C. *Campus Computing, 1997: The National Survey of Information Technology in U.S. Higher Education.* (Encino, CA: Campus Computing) December 1997.

18. Bowen, Howard R. *The Costs of Higher Education.* (San Francisco: Jossey-Bass), 1980.

19. The 1997 *Consumer Market Study* of the Software Publishers Association (SPA) reports that 38 percent of U.S. households own a personal/desktop/notebook computer. Several other consumer market studies published during 1997 also reported household ownership at about 40 percent. As the SPA survey was conducted during January 1997, it is likely that ownership levels have risen a few points over the past year.

20. A.W. Astin, et. al. *The American Freshman: National Norms for Fall 1995.* (Los Angeles: Higher Education Research Institute, UCLA), 1995.

21. The University of Phoenix's parent company is The Apollo Group, a publicly traded corporation (NASDAQ Symbol: APOL).

22. A lively, and compelling study of VC-burn is Jerry Kaplan's 1995 book, *Start-Up: A Silicon Valley Adventure* (New York: Houghton Mifflin Company). Kaplan details with insight and irony how his VC-funded start-up, Go Corporation, consumed $75 million in an ultimately unsuccessful attempt to develop and market a pen-based computing system, similar to the technology now found in the Apple Newton.

23. Rogers, E.M., *The Diffusion of Innovations,* Fourth Edition (New York, Free Press), 1995. Indeed, referencing data from the 1996 Campus Computing Project, Rogers comments that "the dramatic gains in the rate of adoption of information technology [in instruction] are undoubtedly related to the growing public awareness of the Internet, as well as the expanding access to, and use of, personal computers across broad parts of American society." Rogers, "In Response," *Change* (March/April 1996), p. 29.

24. Green, Kenneth C. Campus Computing 1997. (Encino, CA: Campus Computing). Summary information about the 1996 report is also available via the AskERIC Web site: http://ericir.syr.edu/Projects/Campus_computing.html).

25. The 1997 Campus Computing Report reveals that more than 60 percent of U.S. campuses have some sort of IT-support center intended to help faculty identify and perhaps even develop IT interventions for their classes; however, less than 12 percent of U.S. campuses provide any type of formal "recognition or reward" for these efforts as part of review and promotion decisions.

26. Faculty unions in the United States are very concerned about the growing role of IT in collegiate instruction. Indeed, technology issues may emerge as a major point of confrontation in union contracts in coming years.

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Learning Tools Within a Context: History and Scope

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Overview

The Internet has been thrust into the public consciousness during the past few years, and its incorporation into an increasing number of domains such as education or marketing is proclaimed, celebrated, and generally accepted as inevitable. One such domain is the use of the Internet to enhance learning so people can gain the skills necessary to obtain jobs, better perform the jobs they already hold, or retrain themselves when they are displaced from those jobs. This application of the Internet to worker training and education is tantalizing to both private and public decision makers. Yet precisely how, or under what conditions, the Internet can best be used to enhance worker competence remains unclear. What is clear is that the Internet will always be used within specific contexts that affect its use. Context here refers to the often-tacit "background" in which an activity such as using the Internet occurs. Accordingly, the goals of this paper are to establish the salience of context, and to develop a framework for examining issues of context in specific uses of the Internet for training and education.

The paper consists of four sections. First, it reviews what is being said about Internet-Based Training (IBT) in the training and development literature in order to determine some of the forms IBT takes, as well as its perceived strengths and weaknesses. This literature is characterized by a tacit model of IBT as it is embedded in organizations such as companies, and the characteristics of this model are explicated. Second, IBT is explored from the perspective of a naive individual user seeking to acquire the skills and knowledge necessary to obtain a new or different job. The lessons learned from this brief sojourn are summarized, and the exercise itself is used as the basis for developing a contrasting model of Internet use in training and education. The two models of IBT are then used as a framework for discussing how context might affect specific applications of IBT. This discussion elucidates the complexity of the challenges surrounding IBT, and provides a systematic way of identifying and exploring them. The final section raises some questions for research, and discusses the larger societal implications of IBT.

IBT: A View From the Training Literature

Even a cursory review suggests that IBT is a heterogeneous phenomenon. It includes use of familiar Internet services such as e-mail, downloading files, bulletin boards, forums, and newsgroups. Real-time teleconferencing, interactive and self-paced tutorials, and live online classes with instructors and other students are also included (Crenshaw 1997; Marquardt 1996). Munger (1997), for example, stresses the variety of IBT applications, including simple, text-based question and response tutorials, multimedia applications, hypermedia links, and live videoconferencing. Despite the potential for interactivity, which is viewed positively by most commentators (Hamalainen, Whinston & Vishik 1996), some also indicate that

IBT is currently used primarily to deliver basic textual information such as lists, pamphlets, and lectures (Crenshaw 1997). IBT is also often embedded in other technologies such as CD-ROM, audiotape, videotape, and multimedia. This suggests that people do not simply encounter IBT, but rather very specific variants of it, and the latter may be embedded in other media. The diversity of such encounters suggests that any comparisons among IBT projects should carefully consider the specific forms they take, and how they are embedded in learning systems.

Commentators also discuss at length the characteristic strengths and weaknesses of IBT. Regarding the former, some deem it useful when the training audience is large and geographically dispersed, with individual learners isolated from each other or the source of the curriculum (Glener 1996; Gordon & Hequet 1997). IBT also brings benefits to individual learners, especially those who are Internet savvy. For example, its convenience is noted, since IBT can be integrated into the schedules of busy learners, and it may be used in the comfort of their homes. Marquardt (1996) notes this allows people to initiate their learning experiences when they are most motivated to do so. The convenience of IBT is also reflected in self-paced tutorials that meet different individual learning styles, and the needs of learners with diverse backgrounds and levels of preparation.

IBT also has characteristics that make it useful for some purposes, such as for transmitting standardized technical information (Horowitz 1997) that is specific and concrete (Gordon & Hequet 1997). This information can be rapidly updated, thereby allowing a widely dispersed audience to have access to identical, current information (Crenshaw 1997; Horowitz 1997). Other strengths of the medium include the capacity to support individualized instruction, simulations, and interactivity among learners and instructors (Gordon & Hequet 1997; McCarty 1996; Welch 1996; Wulf 1996).

IBT also potentially brings several organizational benefits (Rand 1996), especially reduced training costs. Notably, it reduces travel costs associated with bringing dispersed learners to training sites. It also reduces handling and postage costs associated with delivering updated training manuals or CD-ROMS. IBT is a relatively inexpensive way to deliver training (Glener 1996), and it can bring tremendous economies of scale in disseminating information. These benefits can be captured by smaller companies if the training can be standardized (Baillie 1996). Such companies often find it difficult to support in-house training or to afford off-site travel to training sites. The rapidity with which information can be delivered and updated also supports "just in time" training, in which new information is delivered precisely when it will be used by the learners (Gordon & Hequet 1997; Marquardt 1996). IBT also offers the capacity to monitor learner progress through tutorials, to adjust the tutorials or deal directly with slow learners.

A final organizational advantage is the ease with which training can be interrupted so that trainees can return to their regular duties (Crenshaw 1997; Welch 1996). This allows organizations to deliver training with minimal planning around the work flow: A simple e-mail message can be used to pull people away from training and back to their regular duties should it become necessary. Likewise, many small employers now find it difficult to do without key employees for even short periods of training. IBT can help address this problem by delivering training in the workplace.

Despite IBT's strengths, the literature also identifies numerous weaknesses. First, it may not be appropriate for many important training goals. For example, if changing worker attitude or motivation is a goal, IBT may not be the ideal training method, nor is it appropriate when instructor charisma is important (Sims 1996). It is not ideal for developing "soft," interpersonal skills, nor is it best for most team-building endeavors (Gordon & Hequet 1997; Sims 1996). Sims (1996) also notes that it is inappropriate for developing infrequently used high level skills, or for handling novelty or addressing new, unanticipated questions.

Gordon and Hequet (1997) comment that material must be organized into modules that fit the constraints of IBT, and therefore much of importance may be left out. If this "fitting" process proceeds unconsciously, then trainers may not be aware of gaps in the training, and workers may not otherwise obtain the needed information. The very convenience of IBT can also be seen as a limitation: Learners do not have the time away from work to reflect upon what they have learned. That reflection may be critical to incorporating new skills into existing work practices.

Other weaknesses of IBT are due to current technological constraints, notably bandwidth limitations and the difficulty in rapidly downloading files. Some of these technical constraints will undoubtedly be resolved in the long term. In the short term, performance can be improved through better and more costly equipment. Cost is an often-mentioned weakness of IBT. Although delivery costs may be relatively inexpensive (Glener 1996), obtaining the necessary bandwidth can require significant investment, as can developing high quality instructional material. The latter requires significant time to develop, test, and modify. Equipment and material also must be maintained, a cost that is typically underestimated in IBT (Hall 1996).

Some weaknesses of IBT are centered more on individual users. Not all learners are equally comfortable with technology, and many do not know how to use the Internet. Training in use of the Internet at some minimal level is a prerequisite for effective training programs, but IBT may still not meet the needs of some learners. Gordon and Hequet (1997), for example, maintain that while multimedia seemingly addresses different learning styles, it is best for learners who prefer to "hack" their way through information. The social isolation of IBT users can also affect their motivation to learn. Classrooms, some argue, increase the pressure to learn. Although a benefit of IBT is that it can free participants of the effects of race, gender, ethnicity, and other markers of identity, the interaction that occurs may be a poor substitute for the face-to-face kind. Indeed, Munger (1997) cautions trainers about developing technologically based programs when simpler, face-to-face ones are just as cost effective.

Individual isolation may, according to some commentators, have important organizational consequences. It may reduce the small talk that results from bringing people together for training. Such spontaneous talk may help people work through and assimilate the curriculum, and it may also support serendipitous learning about other facets of organizational life. Another risk in using IBT is that, by making training easier to deliver, it allows numerous organizational problems to be converted into training problems. This, of course, can mask deeper organizational problems that should be addressed (Hall 1996). For example, the very need for "just in time" training may be driven by the organization's inability to plan.

What can be learned from this admittedly cursory review of IBT and the professional training literature? First, IBT is not a homogeneous and well-defined phenomenon, but rather it takes a variety of forms and

serves various individual and organizational purposes. Conclusions about IBT must always recognize the specific forms it takes, and how they shape outcomes for different learners.

Second, training itself is variously defined, and ranges from the distribution of data with minimal comment to the preparation of interactive simulations, and even complexly structured courses of study. It appears that dissemination of any information by the organization may be labeled as "training." Again, generalizations about the suitability of IBT must clearly explicate the meaning of training in the specific application.

Third, IBT is always embedded in some larger training or educational endeavor: It is never done in a vacuum. Typically, it is one of several technologies which together compose a training module. Furthermore, even if used alone, IBT is still embedded in the user's other learning experiences, as well as how it fits into their daily work practice.

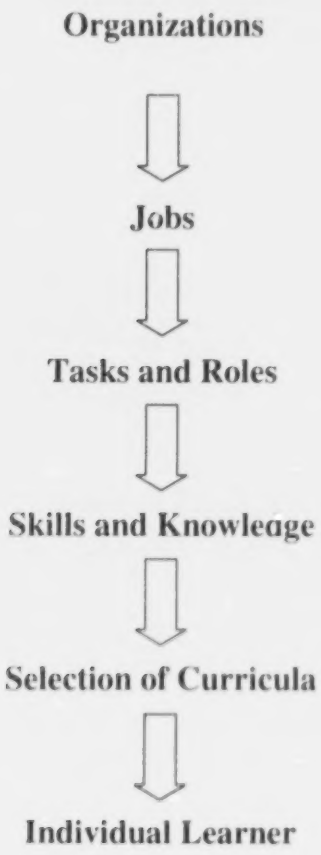
Fourth, much IBT occurs among professional or technical workers who are more likely to be familiar with computers. This allows many discussions of IBT to proceed as if use of the Internet per se is transparent. This, of course, may not be the case for workers lacking a technical background or for those preparing for jobs that will not regularly use the Internet.

Fifth, IBT assumes that what is necessary to perform a job is known, and can be formalized in a way that permits development of unambiguous training curricula. This assumption is predicated upon an organizational distinction between individuals who are empowered to deliver a normative model of how work should be performed, and other individuals who perform that work. However, such normative models of work may not accurately reflect how work is necessarily performed in actual contexts (Darrah 1995).

What is most striking about IBT as it is presented in the training literature is that it is typically embedded within the context of a specific organization. It is the organization that has a problem for which training in general and IBT in particular is the solution. In effect, IBT is embedded in a tacit system to improve learning. There is an organization or employer within which are jobs. The latter, according to various job analytic frameworks, can be broken down into the tasks that people must perform and the roles that they must fulfill. Tasks and roles require that job incumbents have specific capabilities (skills and knowledge) that they use on the job. As tasks and roles change, or as individual capabilities erode, the organization identifies training needs and arranges for the training or education that hopefully will provide the necessary competencies in individuals and groups. The ultimate component of the system is the individual within the organization who is the recipient of the training effort. Following this model, trainers may face a challenge in finding or developing appropriate training materials, but the trainee is typically not faced with such a daunting task.

The application of IBT as a solution to an organization's "skills problem" can be conceptualized as a model that is diagrammed as follows:

Table 1.—Application of Internet-based training to an organization's "skills problem"



Like any model, this one simplifies a more complex reality. However, it serves two important purposes. First, it allows us to see that accounts of IBT as presented in the training literature do not constitute neutral descriptions of how the Internet enhances training and education. Instead, those accounts are based on tacit assumptions that in turn affect how IBT is conceptualized and applied. Second, the model sensitizes us to the possibility that IBT may be embedded in very different contexts. Specifically, we may ask how IBT unfolds in the absence of the taken-for-granted organizational context. In order to answer this question, we must leave the world of professional journals and sit at the computer terminal.

IBT: Surfing Sojourn

A sojourn through the virtual terrain of the Internet can be a daunting journey for a novice whose search for job training is fictive, but whose ignorance is real. Search engines such as "training," "Internet-Based Training," "vocational education," "job training," and others produced a large and mixed collection of sites of varying usefulness, as is familiar to habitués of the virtual environment. Offerings included well-structured

programs of study for teaching conversational French (http://www.elok.com/lef/), virtual universities that offer a broad vocational curricula (http:www.uol.com); self-contained, interactive modules such as "The Interactive Patient" (http://medicus.marshall.edu. medicus.htm); and training courses that deal with topics of relevance to particular organizations. For example, Lawrence Livermore National Laboratories (http://www-training.llnl.gov/wbt/wbt/) has developed online training in handling radioactive hazards and other safety issues of concern to nuclear laboratories. Also found were miscellaneous ramblings about the Internet and myriad other subjects. Addresses had changed, pages would not print, and some sites promised results to come in an unspecified future. This, of course, does not mean that IBT is impractical or irrelevant, only that it requires considerable effort by the user. Acknowledgment of this fact is important, for the novice sojourner on a real quest is unlikely to find clear road signs guiding the way.

Transfixed by the screen, I watched sites roll by, and with eager eyes and flying mouse, I explored. And despite the obviously unsystematic nature of my inquiry, patterns emerged from the sites. First, the vast majority of sites deal with training in effective use of the Internet. This impression is confirmed by Baillie (1996), who reports finding over 7 million headings under "Internet" and "training": 6.75 million of them concerned training people to use the Internet. Indeed, most educational or training programs included modules on building the Internet skills necessary to complete the remainder of the program. Other sites address how to develop and market courses on the Internet. These range from technical advice to broad suggestions, but they generally do not include examples of successful courses. These points are likely obvious to denizens of the Internet, but they are nonetheless salient if IBT is to be further broadened: the terrain appears infinite and is not well marked. The Internet is not yet a transparent tool for learning, but rather one that requires training to use.

Second, most training and education programs are targeted at information technology professionals who are already computer savvy. The emphasis is on courses in specific programming skills. For example, the NIIT NetVarsity "was set up in response to the needs of today's IT Professional. With business (sic) environment becoming more dynamic, organisations (sic) and individuals feel the need to acquire and update skills continuously" (http://www.niitnetvarsity.com/about.htm). Instruction is offered in the form of one-hour, trademarked "Skillettes" such as "Getting Started with Oracle 7" and "Introduction to HTML Programming."

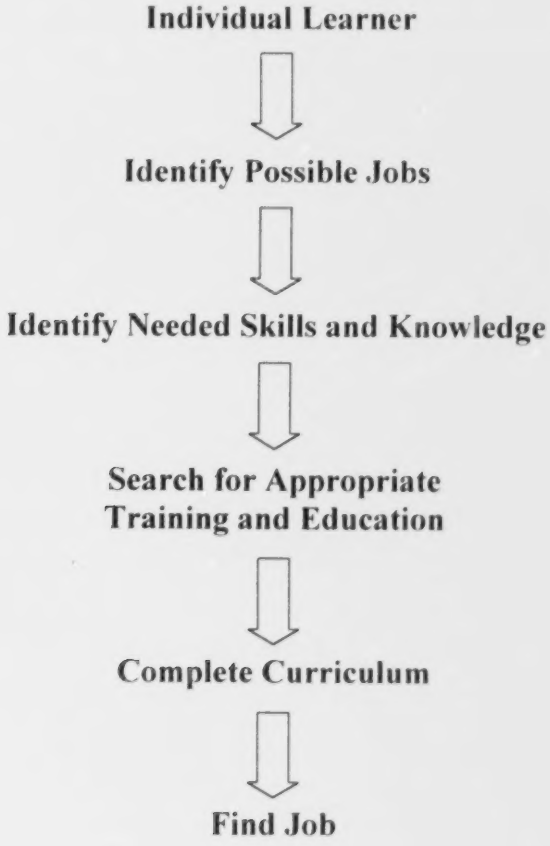
Third, learning opportunities range from courses that are conducted exclusively over the Internet using a variety of its features in different ways, to those which are advertised on the Internet but whose instruction is delivered on audio or videotape, or even hard copy.

The picture that emerges then is one of great variation in quality, organization, and delivery of instruction, with considerably less variation in the topics of instruction and their target audiences. It is a picture in which skills are incrementally upgraded, not one in which most of one's education is provided at the terminal.

The IBT system that emerges from this sojourn is strikingly different than the one tacit in the training literature. It begins with the individual who is searching for information about available jobs, and the skills and knowledge needed to obtain them. The quest to obtain skills and knowledge *per se* may be broken down into several steps. First, the requisite skills and knowledge must be identified, a task that is not always simple. Second, various ways of obtaining them—including broader education or specific training—must be

located and assessed. And third, the programs to provide the skills and knowledge must be completed. Of course, the quest to obtain training or education for particular jobs may be complicated if the jobs desired change while the search process continues.

Table 2.— Individual-centered model



The model sensitizes us to the hopeful worker facing and investigating a daunting array of jobs and ways of preparing for them, including IBT. He or she confronts an enormous challenge of searching for information, selecting that which is relevant, and then assembling a package of materials that will provide the requisite skills and knowledge. If the IBT system in the first model is a tacit one, here it is a system constructed or created by the inquiring individual. This structural difference between the models has enormous consequences for considering IBT as a learning tool within a context.

Questions of Context

The two models developed here can be used now to guide our thinking about the contexts within which IBT occurs. We begin by contrasting the training goals in each model, and how they might be integrated into the learner's life. In model 1, the learners are either augmenting their capability to perform the same job, or

they are preparing for a new job within the same organization; the latter might well be a promotion. The changes they are undergoing are incremental in the sense that they remain in the organization and often in the same job. This is not to underestimate the impact of training in this model, but only to emphasize that much of the person's work remains constant. In model 2, the goal is quite different. Here the changes in the worker may be dramatic, since the learner might be abandoning one identity and transforming into someone quite different. If the abandoned identity is something the person valued, then training or retraining may be undertaken under stressful conditions.

In the literature underlying the first model, the larger lives of employed worker-learners are not mentioned. This is understandable since the incremental changes in worker skills and knowledge can usually be readily assimilated. The larger lives of learners in the second model may, however, be quite salient to their use of any learning tool. They may not simply be developing new capabilities, but transforming the fundamental patterns of their lives, how they think about themselves, and their relationships with family and friends.

Independent of the incremental or transformative nature of training is the issue of the personal conditions under which the training is undertaken. In model 1, the learner has a job, often one that is sufficiently secure to warrant organizational investment in his or her capabilities. The simple fact of a regular paycheck, with its salubrious affect on individual and family welfare, is itself significant. This situation may contrast with that in the second model where the learner is seeking not only skills and knowledge, but a (different) job and paycheck as well. Prolonged unemployment and the extent of unemployment in the larger community may exacerbate the sense of urgency under which learning is pursued, and family resources, both financial and emotional, may be stretched or depleted.

Stress, turmoil, and inadequate resources are not characteristic of everyone who is preparing to find a job, and of course, they also characterize the lives of many people who are employed. Still, the condition of being without a job is fundamentally different than that of having one. A job can provide both the financial resources to stabilize personal and family lives, and the platform from which to incrementally upgrade skills and knowledge in preparation for something better. Learners in the second model need not necessarily be without jobs, but if they are we should expect that IBT will proceed quite differently than for the employed learner in the first model.

Again, an implication is that IBT may be applied in model 2 under conditions that are probably less than ideal for learning. There may well be a sense of urgency and a perception that the stakes for one's life are quite high. Specifically, delays in searching for jobs and appropriate training or education may be especially frustrating if they are exacerbated by the very technology intended to solve the problem "efficiently." Likewise, the convenience of IBT may be less relevant to people who either lack the necessary technology in their homes or the conditions in the home which would permit them to learn. If an advantage of IBT is that it reduces off-site training time, we should remember that its cited disadvantages include isolating the learner, minimizing the markers of training as a special activity, and reducing the time for reflection upon what is learned. The simple fact of isolation may mean that the learner lacks the social support that can be provided by other students. This issue is especially salient if family members do not support the person's educational endeavor. Of course, there are likely ways that IBT can be applied that do not isolate learners, that provide them with the "away time" from potentially stressful lives to learn, and that foster the reflection that underlies deeper learning.

The fact of employment implicit in the first model also raises another issue of implicit context: the opportunity to implement and test the lessons learned. Learners in organizations are typically in situations where they can easily apply the lessons learned, and thereby assess both the utility of the lessons and their own mastery of them. This assessment allows them to determine where the lessons fit into their daily work practice. Specifically, the opportunity to apply lessons may permit learners to develop sharper questions for instructors, or it may result in awareness of other skills and knowledge that must also be mastered. It can also help learners to adjust rapidly their own efforts at learning. This ability to judge how the training will likely be relevant—or irrelevant—to work practice can allow it to be tailored to the actual exigencies of work.

The situation in the second model is quite different since learners are without the opportunity to assess the utility of the lessons learned in performing a job. Of course, they may be able to correctly judge whether the training is necessary for *obtaining* a particular job. Still, they likely lack the opportunities to refine their mastery of the lessons learned. They are, in effect, taking a gamble that *this* training will actually provide the skills and knowledge recognized as such by employers.

Learners in model 1 are also acting within a social context that allows them to discuss what they have learned with other people. The latter include individuals who are affected by the trainee—customers, clients, suppliers, and so forth—and others who received the same training. This suggests that there is a large component of learning that is social in nature. Narrowly construed, this means that people do not learn simply by pondering training and educational materials in isolation, but also through interacting with other people. A broader view emphasizes that people are enculturated into larger worldviews that allow them to make sense out of the bits and pieces they otherwise learn. Formal training or education is thus already embedded in on-the-job learning that nurtures the "know how" needed to work effectively (Darrah 1996; Kusterer 1978). Occupational or professional training, too, provides worldviews for assimilating new knowledge. For these learners, IBT (or any training) is but one component of a larger learning system that has both individual and social histories. They are not simply relying on IBT to train them to do the job, for they bring much to the training situation that helps them make sense of the latest lessons. Thus, learning here is less an individual activity than a social one conducted with people best qualified to judge its impact.

Learners in the second model are, of course, still learning in a social context, but it is usually quite different. They have fewer opportunities to discuss and assess what they are learning with the people who will be affected by their actual job performance. Here the formal training opportunities are the focus of learning. Still, it is important to note that they, like any other learners, enter training or educational settings with preexisting skills and knowledge. Many researchers have commented that both children and adults bring savvy to the classroom that can provide foundations for further learning (Balfanz 1991; Lave 1988). Identifying and incorporating these foundations into new learning can both acknowledge learners' already existing capabilities and support their assimilation of new skills.

The preceding comments have several implications for how we consider the application of IBT to worker training and retraining. One implication is that we should appreciate the complexity, extent, and tacit nature of much of the learning that occurs among job incumbents. Likewise, we should be modest in our claims about how IBT can improve worker training and retraining, for it will only be one component of a larger system of worker preparation. Determining where it best fits into this system is an important question in the design of any training program.

Another implication is that people bring considerable resources with them as they learn new skills and knowledge, and those resources can be used to support additional learning. Identifying individual and group variations in those foundations and incorporating them into IBT might both support the confidence of learners and enhance their mastery of new capabilities. The salience of this point is reflected in the fact that IBT is typically used in training workers holding technical, often computer-related jobs.

A final implication is that IBT could be used in ways that recognize the social nature of workplace learning. Training that reduces individual isolation and builds meaningful interaction among learners is consistent with how much workplace learning occurs. This is not to argue that sociability can be ordered up by IBT developers, only that it may be possible to apply IBT in ways that support learning to learn, not just the transfer of immediate, requisite job skills.

The organizational employer in the first model of training also makes a significant contribution, and aspects of it may not be immediately apparent. The organization contributes much to training by identifying training needs, and developing or purchasing the necessary curricular materials. The organization is able to assess the abilities of its learners, and focus the training on specific target audiences. The latter can be selected so that their members have specific characteristics in common, or if desired, a more heterogeneous audience may be selected. The organization can provide and support the required technology, including the capacity to monitor learner progress. It can provide expert coaching or other assistance to help learners master the material, and it can perform the critical task of certifying—to its satisfaction—that learners are indeed adequately trained.

These tangible organizational contributions are both significant and obvious. We have seen that the literature on IBT cautions potential users that the costs of the technological infrastructure and curricular development can be significant, on going, and underestimated. In addition, limitations of bandwidth and computer speed can affect the comfortable use of IBT. The organization can provide support so that the learner is able to focus attention on mastering the material, and not coaxing an inadequate delivery system to work.

Individuals and job training centers may not have access to the financial resources to purchase either adequate technology or expert assistance. For example, Rosen (1996), in a survey of adult literacy practitioners, found that they experienced widespread difficulties in using the Internet. These difficulties involved the technology, its integration into an office, learning to use Internet features, and finding the time to take on yet more responsibilities. The picture he paints is consistent with the experiences of many schools that obtain computers for the classroom, but then find they have insufficient resources to use them well. While many employers certainly lack the resources to fully support IBT, those capitalizing on its economies of scale are likely to be able to support an adequate infrastructure for IBT.

Other facets of the organizational contribution to training are less tangible. The organization has the capability to define what constitutes training, and organizational definitions can vary widely. This point is important if we are to understand the various activities that "count" as training. For example, enrollment in a class and receiving an updated list of product specifications are very different activities, but both may count as training within an organization. Most important is the organization's capacity to define jobs and requisite skills, and even what constitutes a successful outcome of training. This last point is subtle but important. The organization has the capacity to define success and failure by its own standards. Regardless of how the

learners judge a training program, the organization can make its own pronouncement, and it can allocate its resources accordingly. This is not to indulge in cynicism, only to recognize that training in model 2 is ultimately judged by external organizations—potential employers—who decide whether an applicant's preparation is relevant and sufficient. The learners here are effectively gambling that they have made the correct choices. In the first model, the final judgment is made by the learners organization, and they take less risk that the training they choose is appropriate. Indeed, they most likely do not even make that choice.

The organizational context of IBT is not limited, however, to conceptualizing required skills, sanctioning specific training curricula, providing technological infrastructure, or legitimating definitions of success and failure. Indeed, the organization's formal contribution may be less significant than its role as an arena for communities of practice (Lave & Wenger 1991). The latter emerge among people who share, to differing degrees, common work practices. Such communities of practice may transcend the boundaries of particular organizations, and paradoxically, they may be invisible to many people within any particular organization. However, they may play a central role in developing work practices and in filling in the interstices of formal training programs.

How we think about work can have profound effects on what we deem to be reasonable preparation for jobs. I have elsewhere discussed a rhetoric of skill requirements in which work is decomposed into discrete skills that are somehow required in order to do the work. These skills are seemingly obvious and can be described by both expert incumbents and external job analysts. I have argued that while useful for some purposes, this perspective provides an impoverished view of how people work and how they learn to work. For example, much of importance may be omitted if jobs are viewed as bundles of mutually exclusive skills that inhere in the worker and job, rather than in the workplace. Skills may not be required in an obvious way. Specific skills are sometimes required to obtain jobs and then move out of them, but not to perform them. Defining required skills may reflect managerial prerogatives as much as the exigencies of work (Darrah 1994, 1996).

All this is not to perform a sleight of hand trick in which "unskilled" people can somehow perform "skilled" jobs. But it does suggest that the nature of workplaces and how they support or inhibit learning is consequential, and people may differ in the skills they deem required to perform particular jobs. It also suggests that the larger enterprise of thinking about work and workers just in terms of discrete skills may provide an inadequate basis for developing effective worker preparation programs.

A complementary perspective on work has developed over the past decade. This perspective builds on the work of scholars such as Jean Lave (Lave 1988; Lave & Wenger 1991), Sylvia Scribner (1986), and Lucy Suchman (1987), and it focuses on how people think and act within specific technological and social contexts. The rhetoric here is of practical reasoning, situated learning, communities of practice, and the social organization of work. A complete discussion of this contextualized view of work is far beyond the scope of the present modest effort, but this view does have several implications for the potential application of IBT to training and education.

First, jobs undoubtedly differ in their "context dependency." Much professional education, for example, enculturates people into a worldview that is far broader and deeper than a set of skills. This worldview helps make new tasks meaningful, and it shapes the practice of daily work. Indeed, we may even think of it as an effort at internalizing the context within which work is made meaningful.

Context is also important to the work of nonprofessionals. I have described elsewhere the sensitivity of machine operators to context, and how the excellent operator sees, hears, and feels things that are invisible to the tyro. This context sensitivity is localized, and it may not readily transfer to radically different workplaces. I have also described the work in a computer assembly plant where many workers held certificates as electronic technicians. They moved easily between employers and engaged a highly standardized world of computer components, wiring, and testing. Still, technicians were members of a community of practice, in this case one based largely on national origin, and the one technician who was not of the correct background (and who attempted to use his status as a white male to build solidarity with the company's largely white management) remained on the periphery of the community of practice. He ultimately failed in his job. This larger point, that context matters in any job, is also made by Orr (1997), who explores how photocopier repair technicians perform their work, and it is a point made repeatedly in Barley and Orr's edited collection on technical work (1997).

The argument here is simple and important. Skills training writ large is only one strand of learning how to work; participation in a community of practice may be equally important. IBT can undoubtedly help in providing some information and training to perform tasks, but it is highly unlikely to replace the larger systems of learning that occur at work. Identifying where and how IBT becomes integrated into the various streams of information and arenas for learning is perhaps a more productive strategy than simply formalizing job requirements and relying on the Internet, or any training program, to disseminate them. Thus, IBT has implications not only for training in preparation for jobs, but for the nature of jobs and the learning tools job incumbents have available.

A corollary of contextual approaches to work is that they see obtaining and holding most jobs as being only partially dependent upon technical skills. Employers hire based on a variety of attributes, including the applicant's attitude and mastery of the "soft" skills of communicating and managing interpersonal relations. This is not to say that technical skills are irrelevant, only that they may not be enough. And, as discussed earlier, IBT is considered a poor choice by most commentators for developing those "soft" skills. This suggests careful consideration anytime that IBT is used to prepare first-time workers or workers making a shift to employment where "soft" skills are important. Ways of building in opportunities for broader workforce development, including the ability to learn, and to work effectively with other people, may be especially necessary here.

The very modularization of learning in IBT is germane to the issues raised. While it may be suitable for workers making the sort of incremental change in skills discussed before, it may be inadequate for many jobs or people. Again, this is not to say that IBT has no role to play in training, only that much of successful practice eludes modularization; interstices in formal programs will persist. Ways to develop that practice can complement a narrow focus on skills and thereby assist learners in becoming more broadly employable.

Finally, the contextual approach to work implies that training situated as much as possible in actual work settings should be more effective. The danger, of course, is that training can become inflexible and prepare people for only very specific jobs. However, such training can also be done in ways that combine real and local settings with broader and more general training lessons (Harrison 1995).

Caution is thus warranted in applying IBT to worker training and retraining if it is seen as a way to deliver standardized training that is applicable regardless of context to an undifferentiated pool of applicants. This general approach has met with little success, and IBT, with its emphasis on economies of scale, could be used to automate a risky training approach. On the other hand, again, note that IBT may be entirely

appropriate for incorporation into an integrated package of training or education, but the claim that it will replace existing workforce development is tenuous.

Appropriate training or retraining obviously must consider the difference between the capabilities of the person and those required of the job. The size and nature of this "gap" varies widely. Training already technically sophisticated people to add yet another skill to their repertoire is quite different than training workers to prepare for jobs in entirely new industrial sectors. The tasks of preparing unemployed youth or the hard-core unemployed for initial employment in decent jobs is different yet. I have argued that being employed in itself often brings many tangible and intangible resources to bear on learning, and that information technology workers have been so enculturated as to be able to place new training or education within a meaningful context. Despite differences in experience, professional workers are by definition the end products of extensive enculturation so that they are better prepared to learn to learn.

Implications and Issues

This paper has developed two models of IBT in context in order to raise issues that are salient to it as a learning tool. The hope is that by doing so the use of IBT to support more effective learning and workplace practice can be facilitated. Many specific questions have been raised along the way, and here I review some of the major issues that have emerged.

First, it is clear that learning how to work is a complex process, one in which training narrowly conceived plays only one part. Just where specific forms of training—and more broadly, *education*—fit into job preparation is a general problem not unique to IBT. But it is an issue that those who attempt to use the Internet for training purposes must address. New technologies are often promoted as replacements for existing ones, but in fact they are typically added to existing social and technological systems. We may expect this general lesson to again hold true, and ask where and how the Internet can most effectively support learning by future and present workers.

Related to the first issue, we may expect that the full potential of IBT will not be realized if its primary "training" use is to rapidly disseminate standardized information. Accordingly, a second issue is the development of IBT that relies less on the modularization of learning, and is more of a tool that supports open inquiry and conversation about work. This may challenge tacit, deep-seated assumptions about the allocation of power in the workplace.

Third, IBT is spoken of as if it is a topic removed from the larger issue of how people learn in workplaces, and how workplaces can be designed that support learning. Most discussions of IBT speak of "empowered" workers who are responsible for managing their own careers, a responsibility many employers formerly assumed. Yet many workers have been conditioned to avoid asking questions at work, and many workplaces explicitly limit workers' rights to inquire (Darrah 1996). The American educational system, too, has all too often defined learning as the passive receipt of information, and not the active creation of knowledge. If workers are to become bold and empowered learners, then many of those workers will need assistance along the way (Hatcher 1997). Furthermore, many workplaces will have to undergo fundamental change if learning at work is to be supported.

Fourth, if IBT is to play a role in worker preparation, then how can individuals be supported in their quest for job training (broadly writ) on the Internet? Perhaps the most fundamental structural contrast

between the two models developed in this paper is that between the model 1 learners who are guided or instructed in their quest for training, and the lone model 2 learners facing the infinity of cyberspace, uncertainty about which jobs to pursue, and ignorance about how to assemble a coherent educational or training package. If IBT is to occupy this niche, then some sort of support seems necessary, and various models for providing it can be explored. This support may be as simple as human guides who are available to help the person navigate this new terrain. Such assistance might be made available at job training centers. Brokers, who assemble customized packages of training materials for specific jobs (Hamalainen, Whinston, & Vishik 1996), are another alternative. Or even innovations in Internet software might change the current "learner-centric" model of IBT by enabling instructors to create and guide "learning groups" (Yeh, Chen, Lai, & Yuan 1996).

Fifth, if the lessons of situated learning and vocational education are at all valid, then learning to work occurs best when people must accommodate to others in settings that correspond to the arenas in which they will ultimately work. Accordingly, we may ask how organizations can be matched to individuals and training programs. This would provide both real world preparation and reduce the isolation among learners.

Summary and Conclusions

Having reviewed some specific areas for inquiry concerning IBT as a learning tool in context, this paper concludes with some thoughts about even broader contextual issues at play. Thus far, discussion has centered on the lives of individuals, the characteristics of workplaces, and the roles of organizations. This definition of context in terms of individual lives and organizational arenas is appropriate, but it should not blind us to even larger societal issues that are raised by IBT.

One need not be a Luddite to point out that consideration of IBT is being conducted in a country with a history of celebrating technological solutions to problems. Indeed, a reading of the literature about IBT suggests that part of its appeal is that it enhances the latest version of computer literacy that is thought to be required of everyone (Dyson 1997). It is a sort of "medium is the message" argument: Regardless of the specific training content, the mere use of the Internet, or computers in general, has salubrious effects. These effects are promulgated as ones that bring benefits both to individuals, in the form of access to better jobs and richer lives, and to society, since it enhances national competitiveness.

Regardless of how we judge this faith in computer literacy (however defined), there are still the immediate realities of preparing people for current jobs. While many of the latter do require mastery of computers, others do not. The point here is not a curmudgeonly one, only a reminder that the world of work is very diverse and there are real people with pressing needs for jobs now. We should be especially skeptical of the argument that IBT is valuable, even if the content that it conveys is less than stellar. The fact that so much IBT is now directed at people in or preparing for technical careers raises the possibility that such people might be more willing to endure technical difficulties; indeed, they may view them as interesting challenges. For most people preparing for nontechnical careers, however, the content *is* what matters. People will discover soon enough if the content of training or education fails to prepare them for work, and IBT may be discredited as a misguided application of technology.

Perhaps as significant as the hardware and software that provides the infrastructure for IBT are its implicit models of learning and of being an educated person. In much of the writing about IBT, information

delivered is equated with learning, and learners are viewed as consuming information as if it were just another product. The "inefficiency" of the current educational system is lamented, and the availability of modularized, "just in time" training is heralded as a source of cost savings. Learning becomes viewed as data retrieval, and education is simply a means of delivering chunks at the lowest cost.

The irony of this perspective is that many who hold it are themselves the products of broader and deeper educations that encourage thinking and reflecting. Most informational technology professionals, for example, who celebrate the benefits of delivering modules of skills "just in time" for use were not themselves largely educated in this way. This is not to say that issues of efficiency are irrelevant and that the delivery of skills modules is universally to be avoided, only to remind us that it is severely limited as a model for a complete education. Those who apply IBT to new worker training or retraining should remember that it is one thing to include modularized skills training into a larger education, and quite a different thing to conceive of an entire education as composed of such chunks.

Two policy questions are especially important. First, what are the consequences of the different tacit models of curriculum that inform how people are prepared for work? Second, how is use of these models distributed across different categories of people?

The first question raises the issue that different ways of using the Internet as a learning tool may have different consequences for the learners. These differences do not inhere in the technology, but rather in how it is used. For example, do some practices—despite the glitz—place learners in the role of passive recipients of information with little opportunity to question, critique, or reflect? Do other uses result in the expectation that learning is structured as a set of given questions and correct answers? And do still other uses allow learners to creatively synthesize data, find new questions, and generally learn by expanding their thinking into new domains? None of these uses is necessarily right or wrong, and indeed, each is likely appropriate for specific purposes. But they may be very consequential if different categories of people typically experience specific modalities of learning. For example, use of the Internet by professionals who are free to control their use of time on the job may allow them more leeway in exploring cyberspace. In fact, their ability to do so might be required by the job. Nonexempt, temporary, or lower status workers may not have the same freedom, and for them, IBT may result in a sort of job tracking with "bells and whistles." The decisions of private corporations to implement different models of curriculum may be theirs to make, but the use of public funds to support differential access to and ability to use such a learning tool is a significant policy issue.

These final words are not intended as blanket condemnation of IBT. Indeed, the thesis of this paper is that learning always occurs in very specific contexts that shape the lessons learned. IBT is no different, and both its technical capabilities and its use will affect its ultimate impact on education and training by individuals and organizations. The latter issues are generally more difficult to quantify, but they are ignored at our peril.

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Employers as Course Developers: Are They the New Educational Institutions?

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Overview

Sun Microsystems, Inc., designs and manufactures products and services for commercial and technical computing. Headquartered in Palo Alto, California, with more than 20,000 employees worldwide, Sun had fiscal year (FY) 1997 revenues of more than $8 billion. Sun is an industry leader in the design and manufacture of powerful desktop computers, known as workstations, used in scientific, technical, and graphic applications. Sun's concurrent development of an operating system based on the UNIX standard has also established a leadership role in providing enterprises with computer networks. Sun has used its own hardware and software to establish a "network-centric" business enterprise by integrating its computer network into every aspect of business operations. Sun's motto "The Network Is the Computer" summarizes its philosophy that open, robust, and secure systems are the only viable solution to the complexities of large computer networks. By developing large computer networks and a UNIX operating system, Sun has been instrumental in establishing the mechanisms for the explosive growth of the Internet.

Sun University (SunU) is Sun Microsystems's employee training division. A department of Sun's Human Resources (HR) Department, SunU has a staff of 49 and a budget for FY 98 of $27 million. Employee training is more than supplemental in a high-tech company; it is critical to maintaining a competitive advantage. Sun emphasizes progressive employee training methods. Two central traits in the corporate culture are the ability to rapidly adapt to technological change, and an emphasis on continual training. Sun promotes employee education by providing group and department training budgets. Normally, employees self-manage a personal training budget between $1,500 to $2,500 per year. Employees are not required to spend their training dollars at SunU; SunU must compete with external training companies for Sun employee training dollars. In addition to individual training allowances, Sun also provides tuition assistance for university degree and accredited programs.

In conjunction with a department reorganization in FY 95, SunU's financial model changed. The department began a chargeback or "pay as you go" system to supplement its corporate allocation. In effect, SunU began charging Sun employees or departments for educational services. SunU hoped to break even with the addition of the chargebacks. However, since the change, chargeback revenues have steadily increased and allowed a reduction in the corporate allocation. Between FY 95 and 98, while SunU's overall budget increased 125 percent its corporate allocation decreased 38 percent.

SunU's headquarters is located in Palo Alto with additional facilities located in Massachusetts, Colorado, the United Kingdom, France, Germany, Tokyo, and China. These locations reflect Sun's diverse and widely distributed employee base. This characteristic, along with a corporate culture that adapts well to change, has resulted in a wide range of curricula and learning options for employees, ranging from traditional classroom instruction to innovative distance learning programs. SunU's curriculum reflects three general principles: start with a curriculum that emphasizes business issues; maintain

a well-educated, competitive workforce; identify and emphasize the best strategic directions for Sun. The curriculum includes the following categories: field sales, management, individual productivity, new hire, technical, team, and quality training. As would be expected with a computer-related company, the largest amount of training involves technical curricula.

SunU curricula are generated by course managers and designers who typically are either instructional designers with advanced degrees, or experts from another field who have migrated to the training profession. Many of the SunU staff have master's degrees in education, instructional design, or instructional technology, while a few have Ph.D. degrees. The majority of course developers or managers come to SunU with 6 or more years of experience in training design, instructional technology, and education.The competency requirements for course managers and instructional designers include: needs analysis, curricula design, instructional design, vendor management, and program delivery management.Typical duties of a course manager and instructional designer include: training analysis, learning product and/or class design and development, evaluation theory and application, learning theory, training methodology, project and team management, and curricula management.

The majority of curricula is delivered via classroom training. During FY 96 1,400 classes were taught, resulting in 34,000 student days of instruction. Fifteen percent of the participants were internationally based employees. Classroom training is a time tested method of delivery. Some of its virtues include: a simple, low cost, and predictable development process; a highly interactive and responsive learning environment; easy testing; high adaptability to individuals; peer interaction and support; and familiar learning environment. However, limitations include: slower delivery of information, time and place dependencies, travel expenses, and a small collaborative group. One of the main themes of this paper will be to identify when the classroom model of instruction is not the best method of instructional delivery, and how to supplement or replace the classroom experience with computer-based distance learning.

Distance learning, that is, learning that takes place while teacher and student are not in physical proximity, is an alternative instructional method offered by SunU. SunU has implemented major initiatives in the distance learning arena for four primary reasons. The first is that Sun's employee base is dispersed throughout the world. With more than 20,000 employees, Sun can be found in more than 150 countries.The second reason is that technical knowledge changes rapidly, and classroom instruction often cannot keep pace with the need for information transfer. These two conditions create inefficiencies due to time and place dependencies. The third reason is that Sun's powerful and ubiquitous computer network, created with its own products, is a readily exploitable resource for distance learning delivery. Finally, large class sizes reduce the quality of the educational experience, and learners often benefit from an alternative or supplemental program.

In the past, SunU's distance learning followed the correspondence course model: workbooks used in conjunction with audio or video tapes. SunU has also used satellite broadcasts to supplement the distance learning curriculum. SunU has developed a partnership with Stanford University, through the Stanford Instructional Television Network (SITN). In this program, live and/or recorded SITN engineering courses and seminars are broadcast over a microwave system to Sun campuses in the San Francisco Bay Area; Chelmsford, Massachusetts; and Europe. SITN offers more than 250 courses and seminars from Stanford's School of Engineering. Programs include a master's degree program, graduate courses, certificate programs, and course audit options. In addition to the SITN program, SunU uses live video broadcasts to deliver immediate, consistent information to a geographically dispersed audience, such as a broadcast to field technical support offices to prepare for an imminent product release.

A third delivery method for distance learning used by SunU has been computer-based training (CBT). CBT is training that a student receives through a computer. As an example, let us start with a simple model for CBT. SunU could develop instruction to train employees about ergonomics. The training could have several instructional modules, for example, "How the Body Works," "Basic Ergonomic Principles," and "Healthy Work Habits and Exercises." Instruction for the first module would explain how the body's nerve, muscular, and skeletal systems interact to produce motion. Instruction would include text accompanied by anatomical graphic images, simple narrated animations, and level two testing to determine what learning objectives were successfully met.

For the student sitting at the computer, how the computer is receiving the information is sometimes irrelevant. However, for the enterprise that is delivering the training through the computer, how the computer is receiving the instructional content is of profound importance. Understanding how the computer is receiving information is central to understanding SunU's use of its own technology as an instructional tool. Using a delivery model familiar to most computer users, the ergonomics CBT training would be stored on a CD-ROM disk that is inserted in the computer's CD-ROM drive. The computer accesses the information on the CD-ROM, and presents it to the student on the computer screen. As long as the CD-ROM is inserted in the drive, the user has access to the instructional material. The CD-ROM stores a large amount of information, can be readily duplicated in large quantities, and can be carried by the user around the world and accessed at the user's convenience. But let us introduce some conditions inherent to a worldwide technologically based company such as Sun.

What if 1 week after 5,000 copies of the CD-ROM are duplicated a new form of ergonomic injury is discovered? What if the sales force in China needs the material to be translated and localized? What if 3 months after SunU releases the CD-ROM, Sun releases a new line of workstations that are not compatible with the computer program that created the CD-ROM instruction?

Until now the model has been CBT instruction delivered to a *disconnected* computer. A disconnected computer does not have a data connection to another computer. By contrast, a *networked* computer is connected to one or more computers, and is able to send information back and forth through that network. On networks, information is often stored on a centralized storage computer, called a *server*. So for example, the ergonomic instruction could be stored on a server. Through their network connection, 100 other workstations, known as *clients*, can retrieve the instruction from the server. Why use a server instead of individual CD-ROMs? A large part of the reason comes down to economy of scale, currency of information, and compatibility. In the above example, only one copy of the training is required to service 100 users rather than having to ship individual shrink-wrapped CD-ROMs. In addition, the server is controlling the information and preventing outdated information from being distributed. The network server can also mitigate software and hardware compatibility issues, because the instructional program can be modified to be compatible with the latest operating system and hardware.

Let us continue to expand the distribution model. In addition, the material on the hard disk can be modified instantly, whereas modifying and creating a new CD-ROM would take at least a few weeks: to create a master, outsource to a duplication facility, and ship the disks to SunU; then SunU would have to ship the disks to numerous locations. By contrast, as soon as the information is modified on the server's hard disk, all the clients on the network have immediate access to the new information in real time. At Sun, the range of that network is worldwide. A network in a building is networked to other buildings in a campus, and campuses are networked to each other, and the connections continue on a national and international

level. By utilizing its ubiquitous network of workstations and servers, SunU can extend the distribution model for the computer-based instruction to a worldwide scale. This is the competitive advantage SunU seeks to utilize in developing CBT.

Enterprises considering CBT should not be disheartened by the hardware and software infrastructure necessary to achieve such a distribution model. For in fact, many enterprises already have computer networks, often called *intranets*. The emergence of the World Wide Web and its distribution technology has reduced the technical complexity of distributing instruction over an intranet. Employees accessing the World Wide Web via their networked office computer are using a distribution model similar to the one outlined above. However, the difference is that a *client* uses enterprise's *intranet* to access one of the corporation's web *servers*, perhaps many thousands of miles away, and exclusively available to only other members of the corporation.

CBT is often equated with distribution using an individual CD-ROM disk on a disconnected computer. By contrast, distribution models that use networked intranets are often referred to as Intranet-Based Instruction (IBT). We will now explore four SunU instructional projects utilizing IBT. All four projects were developed by SunU's Learning Technology Research and Development group. This groups specific charter is to research and develop new learning technologies for use on an enterprise level. Once developed, these new methodologies are standardized and leveraged among the other SunU course managers and developers. All projects serve a global audience and are distributed through Sun's corporate intranet.

SunU Web: Case Study I

The initial emphasis of SunUs IBT program was in developing a distribution and administrative infrastructure. SunU chose the central point of that infrastructure to be an "electronic store". The SunU electronic store was to be a Web site that would allow employees to view SunUs curricular information and register for courses. Consumers are familiar with electronic store Web sites where products are available for purchase. For the SunU Web site, the products would be the SunU curricula. The term "virtual university" is often used by learning institutions to describe their specific brand of an electronic store. The electronic store also encompasses the database and the repository of computer and network applications which support the system of electronic commerce.

In January of 1995, SunU's Learning Technology Research and Development group began the transfer of its existing online course catalog to the new SunU electronic store Web site.The existing online catalog used a document management system called Helios. Helios was a forerunner of the Portable Document Format (PDF) document management technologies, such as Adobe Acrobat, currently popular for electronic distribution of materials to different computer platforms. Helios allowed the managing of a vast number of documents covering all aspects of human resource and corporate enterprise information. The group's task was to transfer the old Helios online course catalog to the SunU Web site within 4 months.

The fact that Helios was already online should not be overlooked. If organizations are going to develop an IBT program, then that program will be most effective with an online process for fulfilling administrative procedures. Otherwise, time and place dependencies reappear and reduce one of IBT's premier advantages. Consider, if a Sun employee in China had to make a long distance phone call in the middle of the night to California to gather course information, and wait for international mail to deliver course catalogs and registration forms before an IBT class could finally be accessed via the employee's computer, then the advantages of using the product would begin to diminish.

This was one of the reasons Helios was being phased out. It only provided course descriptions; it did not provide a way to register for courses. Registration was handled by a completely separate system called Regis. Regis provided online class schedules, course descriptions, and most importantly, registration capability. This automation reduced the workload on the SunU registrar. If Regis also provided course information, why was the Helios system being used at all by SunU? The answer had to do with the enormous complexity and size of Sun's worldwide intranet. Technical distribution issues precluded Regis from being available to all Sun employees outside the United States. A single electronic store available to every Sun user would eliminate the need to use two different online systems to publish course offerings and provide automated class registration worldwide. Further, an integrated system would reduce maintenance requirements. Rather than maintaining two or more partially redundant systems, one integrated system would reduce the occurrences of contradictory information and the time required to support both systems.

To accomplish the goal of merging Helios and Regis into a Web site electronic store, the development team adopted a phased approach since only 4 months remained until Helios would be phased out. The content was too extensive to attempt ambitious design changes while simultaneously converting the information. The first phase in the process was to convert the Helios Post Script files into the web browser format Hypertext Markup Language (HTML). For registration, two approaches were used. For those users who had access to Regis on their network, Regis was launched from the Web browser via a link. For those who were not Regis enabled, the site provided several pages of alternative registration procedures. At the end of Phase One the most important accomplishment was that the deadline had been met at minimal expense. Useful information was available, and the product could be evaluated for upgrades.

Phase Two, which began in May 1996, made an effort to utilize more of the Web browser's capabilities, especially hypertext. After Phase Two was completed, SunU conducted usability studies which revealed that although a large amount of SunU educational and resource information was available on the site, much of the department information and propaganda was of little interest to most visitors to the site. Most employees accessed the site to research basic information about classes, curricula, schedules, and fees. These employees had little interest in the extensive information on special programs related to specific SunU business units and staff. In addition, in the post analysis, the team discovered that the VP- and Director-level personnel who made decisions and committed resources to custom-created programs, rarely used the site. In other words, too many resources were dedicated to creating web pages that were seldom read by the intended audience and that obscured the most sought after information.

Phase Three took from October 1996 to May 1997 to complete. Phase Three addressed the design issues identified during the usability studies by focusing on defining and serving the customers, who were predominantly employees interested in enrolling in SunU classes. Information was streamlined to focus on the essential class information. The duplication of course information between Regis and the Web site was also addressed. During Phases One and Two, course owners submitted updates of course information for the Regis database by informing the registrar, but they also had to inform the SunU Web publisher, who maintained and updated the new site's content. As a result, information disparities between the two systems began to accumulate, because course owners were not accustomed to the dual process. Even if the information had been correctly submitted to both systems, the process required double maintenance. To solve the problem, a computer program was written to automatically update the Web site from the registration database. The Registrar then had only to update the information in the database, and the Web site would be automatically updated as well.

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Phase Four is presently ongoing. Its primary goal is to complete the integration of the registration system with the Web site. This task involves creating a seamless integration between the Web site's self-service front end and the registration database back end. Because of the large scale of the enterprise's intranet, this involves many challenges, especially with international chargebacks and global access. The SunU database system is aging and at full capacity. Sun's intranet applications typically pull information from a network of several databases. An human resources application can pull information from as many as 16 employee databases. The more databases that are accessed by an application, the more complex maintenance and security issues become. While building an enterprise-wide browser front end for a corporate function is attractive, the complexity and scale of the databases being accessed by a global audience requires a large technical effort. This phase is scheduled to pilot in June 1998. One of the major lessons from the SunU site is to approach development and implementation in phases. The phased approach allowed the team to build and release a product while concurrently designing and developing the next release. Each phase produced a functional product that served its users needs until the next phase was completed. Phase One averaged 20,000 Web page accesses per month (hits); Phase Two, 60,000; and Phase Three over 100,000.

So far, I have emphasized the importance of sending information to the client, but for an IBT program to be implemented, an infrastructure must be in place to receive information as well. This infrastructure must be in place for an electronic store to fulfill all the business functions inherent in the transaction. IBT involves not just delivering information to anyone who wants it, but creating the technical and administrative infrastructure that controls informational content and collects and monitors the necessary data for the training program's business processes. For security reasons, SunU must know the identity of the user. If the employee is being charged during registration, there is chargeback information that must be gathered and processed. If access is only available to certain employees, access privileges must be enforced, and finally, how is delivery of instruction validated? These are issues of accountability, that is, the ability of the IBT infrastructure to gather information from the user to enable the completion of business and instructional processes. This point can be made clearer in the second case study of a SunU IBT project.

Ergonomics Training Case: Study Profile II

The need to achieve accountability for delivered instruction can be clearly seen in SunU's development of an ergonomic Web site. Sun's Ergonomics Program is part of the Environment Health and Safety Department (EHS). The programs goals are to reduce the risk of illness and injury, help employees be more comfortable at their workstations, and increase efficiency and productivity. In 1997, EHS came to SunU with a proposal for an ergonomics instructional Web site. The site was to offer training on how to identify and avoid poor ergonomics in an office environment. SunU chose to build the project because the requirements converged with the Learning Technology Research and Development group's goals related to IBT.

Because of the important nature of the instruction, possible regulatory and liability issues, and registration and chargeback considerations, the EHS site needed a high degree of accountability and reporting detail. The EHS department was responsible for the health and safety of Sun workers; therefore, there was a compelling need to document not only that training had been delivered, but to identify the user who had received the instruction. Implementing chargebacks for IBT was an important issue that SunU needed to address. If course owners were to determine fees and chargeback models, specific and comprehensive tracking data had to be available. Tracking data is

information that is captured by the computer that relates to what part of the instruction has been accessed, when it was accessed, how long it was accessed, and who accessed it. As a new form of training, IBT needed to provide enough tracking data to enable charge backs. This capability needed to allow flexibility, so that different chargeback models could be implemented. For example, one site might charge per use, another might use testing results, a third might use a one-time fee, and a fourth any combination of the three. To resolve these issues, the SunU Learning Technology Research & Development group developed tracking and reporting capabilities for the ergonomics project which could be reused in future products.

The ergonomics site also had specific internationalization and localization requirements that coincided with SunU's development of an efficient network distribution model. In the past, ergonomic instruction had primarily been taught by an employee who traveled around the world and used English to present the material. Besides being expensive, this system did not adapt to local language needs and local/cultural interpretations. In building the instructional site, the SunU group had to achieve a production model that would allow international distribution and efficient development of localized versions.

The development team for the EHS site consisted of experienced employees and contractors from earlier projects. Key team members were the project leader/instructional designer, programmer, webmaster, writer/content developer, graphic artist, and network technician. One of the key aspects of the design and implementation was the emphasis on creating reusable development objects. Objects can be considered the content and programming components that make up the instructional product. Text, graphics, and computer code can all be considered objects. This emphasis on building a project that consisted of reusable objects contributed to achieving a very fast and replicable localization process. Once the text content has been translated, a localized site can be completed in less than 2 weeks. The site is being translated into Spanish, German, Japanese, Chinese, and French. These localized versions of the ergonomics site are targeted to be released in 1998.

SunU utilized the ergonomics IBT to pursue its research and development goals, and therefore "gave away" the product to the EHS Department. Nonetheless, had the EHS department assumed the cost of development, the return on investment (ROI) would have been well worth the effort. The ergonomics site, with a contractor development cost of $60,000, will quickly pay for itself in preventing injuries, increasing productivity and lowering training costs. For its first year of release, it is expected to be accessed by more than 3,000 users. Users have averaged 1.5 hours of instructional time at the site, even though there is as yet no requirement to do so. This instructional model is particularly apt for an enterprise that is geographically dispersed with a diverse employee base. The larger and more dispersed the target employee base, the more cost-effective the distance learning technology becomes.

$alTool and BonusTool: Case Study II

The EHS ergonomics Web site is an easily understood application of IBT. It is hard skills training accessed at a Web site by a geographically dispersed employee base. IBT can also be used for specific procedural training and delivered in a format other than a Web page. Every year during a 6 week period, Sun's HR department conducts its salary administration focal review process. To streamline and standardize the process, the HR department undertook the conversion of the paper process to an online process. After conversion, approximately 1,600 managers were to begin using the two HR computer applications, $alTool (pronounced "sal" as in salary tool) and BonusTool, which replaced the paper forms, memos, and other correspondence encompassing the salary and focal review

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process. Because of the process changes, short time frame, and critical nature of the process, HR decided to accompany the tool with online performance support training. "Teach Me $alTool "was to provide computer-based training on the use of the tools, the new process, and HR policies.

SunU accepted the HR project because it provided an opportunity to develop its IBT program. Because the $alTool and BonusTool applications were based on spreadsheets, which were familiar to the end users, SunU recommended that online training be limited to short, narrated tutorials. The intent of the tutorials was to provide overviews of key functions managers fulfilled in the process. However, HR was concerned that this important business process avoid any delays or inaccuracies, so they opted to accompany the applications with a full-fledged interactive multimedia online training program.

When Sun states "The Network Is the Computer" it is trying to emphasize that a computer network should be a sophisticated, integrated, and open computing environment that a client harnesses to its benefit. The challenge in moving from CD-ROM delivery to a client-server model is in ensuring that each client is receiving the full benefit of being connected to a network. Each network has limitations on how much information it can process and transport. When a network is being asked to deal with more information than it can handle, the performance of the network degrades. What this means in practical terms is that a user accessing training for a client, via a network, may suddenly have very slow performance on their computer, making the training product unusable. For this reason, it is essential that enterprise networks be closely monitored and controlled to ensure that network performance maintains an acceptable standard. One way of achieving this is to mandate maximum file sizes for specific uses of the network, to make sure that networks do not experience bottlenecks and slowdowns in the same way that an overburdened freeway does.

Due to these types of network limitations, the design of the HR project began with the assumption that the total training product be no larger than 50 megabytes. This can be compared to the CD-ROM capacity of 600 megabytes. The inclusion of 12 MB of software needed to run the training reduced the deliverable size to 38 MB. Left with 38 MB for content development, the design had to find an effective balance between the data-intensive multimedia movies, the time and cost-intensive custom interactive features, and the more comprehensive page-turning CBT modules. All development team members had CBT development experience and applied that experience towards a successful product that was streamlined for distribution, yet engaging in content. The Sun employees included the project manager/instructional designer and a network technician. Contractors included the programmer/author, graphic artist, and writer.

Yet despite the highly competent team, development was not without its problems. In delivering training over a huge intranet, many technical issues had to be solved. SunU used an off-the-shelf program to create the training, but the product had been originally designed for non-UNIX operating systems and CD-ROM CBT delivery. The product had been modified to facilitate network distribution, but several problems with the software resulted in unstable performance. After improvising technical solutions under tight deadlines, SunU concluded that the technology used by web browsers such as Netscape were superior when trying to distribute training over an extensive network. Browsers provide a more robust, stable platform for enterprise-level training delivery and lessen the technical expertise requirements.

Because of the high-quality development team, the project was delivered on time and within budget. Total development cost for the contractors was $62,000. Development was spread over more than a 2 ½ month period, and the final deliverable provided an hour's worth of training. SunU's initial recommendation

that the CBT be limited to the online movies was supported by the metrics analysis after the product's release. A summary of the final usage data for $alTool and BonusTool is as follows:

- 148.5 instructional hours provided;
- Used by 43 percent of the target audience spread across 30 locations in the United States;
- Of the users who tested, 100 percent successfully met the learning objectives;
- 99.8 percent of all requests for training were successfully delivered to the client workstations; and
- Instruction delivered at a cost of $300 per hour of use.

Out of a total projected audience of 1,600 Sun managers, 642 accessed some part of the online training. Metrics results showed that there were 1,020 requests to access the online movies, while only 286 requests were logged for the CBT. Because of the limited target audience, and the short 6 week period when $alTool and BonusTool were accessed, the ROI of the CBT was debatable. However, HR's decision to err on the side of caution may have been justified. In business training, ROI analysis is often problematic.

Case Study III: SunSoft's Learning Environment and Resource Network (SS LEARN)

SunSoft is the operating company for Sun Microsystems software development. For SunSoft's Quality and Tools Training Department, a new educational approach was needed for its brain trust of 1,200 software engineers and programmers. SunSoft's business objectives were simple: produce better products, and get them to market more quickly. SunSoft's highly technical environment, characterized by complex and quickly changing information, required maximizing the efficiency and productivity of its engineers by creating mechanisms for sharing the wealth of technical knowledge.

Classroom instruction did not meet the needs of these knowledge workers, because traditional classroom instruction could not keep pace with the expanding body of software engineering knowledge. Engineers, who needed very specific, practical information, did not want to devote hours of classroom time to acquire the information. Frequently, by the time classes were organized and held, the information was too little, too late. As a result, the gold nuggets of knowledge and work-arounds that engineers carried in their heads and collected in their personal libraries had no timely, efficient venue for sharing. Furthermore, software engineers often keep irregular hours and login from home, making remote availability a fundamental requirement. SunSoft assessed the engineers' needs: better access to experts and tools, better organization of Sun technical information, a mechanism for sharing information, on-demand reuse of packaged information, and ubiquitous distribution for easy worldwide access.

In the past, SunSoft's Quality and Tools Training Department had utilized CD-ROM for training. While demanding less time from engineers, this delivery method still did not address all the assessed training needs. SunSoft came to SunU for a distance learning alternative to classroom instruction or traditional CBT. Based on the lessons from $alTool and the SunU Web site, SunU determined that a Web site could meet all the assessed training needs and also function within the parameters of enterprisewide network distribution. After conducting additional meetings and focus groups with SunSoft management, SunU developed SS LEARN, SunSoft's web-based Learning Environment and Resource Network. The SS LEARN internal web site was designed to be an up-to-date resource center for the software development community. Because SunSoft's Quality and Tools Training Department was the internal customer, a strong emphasis was placed on better utilization of software development tools.

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Based on the usability studies from the SunU Web site, it was clear that the instructional design for SS Learn would be as important as the technical implementation. For the site to be successful, leading software engineers had to provide useful content and that content had to be presented in a clear format. In order to successfully marshal content from busy engineers, requests for content were specific and clear. The instructional designer and architect from the SunU site applied a rigorous 4-month instructional design methodology to establish the site's architecture. The result was a robust product that met user and network requirements and allowed for future development without excessive maintenance requirements.

SS LEARN needed to contain both practical information and theoretical content. As a result, the site was divided into two main sections: software tools and a journal. The journal provided theoretical information from the SunSoft development community. The journal was a bimonthly electronic magazine, or "e-zine," of engineering topics where leading Sun engineers published the latest technical and strategic information related to the state of the art and trends and directions. The format of the journal was based on usability principles combining how engineers read paper journals with the advantages of hypertext document layout and content design. For this reason, each article in the Journal began with an abstract followed by a summary and a link to the complete article which could be easily printed as one file. At the end of each article, frequently asked questions, references, and additional resources were provided, including a link to the author's e-mail address. Articles from past versions of the journal were archived and made readily available. An important part of SS LEARN's design was the inclusion of two-way communication channels. The journal always featured a letter from the editor and allowed readers to send electronic letters back to the editor. Letters from the software community could then be posted in the journal. In this way, readers could also submit proposals or suggest topics for future articles.

In contrast to the theoretical emphasis of the journal, the Software Tools section provided a practical, centralized resource for tool training, practice, and the integration of new tools into one's work routine. Tools were listed as an index of links, which enabled users to quickly survey all the available tools. Each tool section began with an overview and an online movie of narrated instruction. Following the overview were lessons on the implementation of a tool. Also available for each tool was a "how to" section which provided step-by-step learning for executing standard tasks and procedures. At SunSoft, developers, programmers and engineers are continually creating custom features for writing, debugging, compiling, and testing software code. A "hacks" section provided tips, work-arounds, and other time-saving information specific to the tool. The hacks section included examples and case studies demonstrating how programmers addressed needs that extended beyond the application's standard capabilities. All engineers were encouraged to contribute to this section. Lastly, a resources section provided a clearing house for the various forms of information pertaining to a tool, including online tutorials, documentation information, links to related Web pages, course catalogs, additional instructional materials, and user group aliases.

As part of SS LEARN's two-way communication design, both the how to and hacks sections had a survey feature for measuring a learners' impression of the quality of the instruction. Each lesson could be rated so instructional designers could evaluate their effectiveness. A "comments" option allowed users to give more in-depth feedback. On a 1–5 Liekert Scale, survey responses on average scored the site's content at very good to exceptional, that is a score of 4.0 or higher.

With its extensive resources and two-way communication features, SS LEARN served as an invaluable instructional resource for the software development community. The journal proved a popular venue for software developers to share their best work. Engineers have expressed great enthusiasm for the substantive

journal articles which have generated fruitful collaboration, discussions, and controversies. The software tools section's popularity is based on its ability to help users to be quickly up and running with a tool. Very specific, technical information can be efficiently distributed to those who need it. New information about a tool can be posted and accessed immediately from any part of the world. Users no longer have to devote hours of classroom time just to gather the specific information they need. Within 20 minutes of its release, the site registered over 20,000 worldwide hits, and continued to average over 300 unique users per day during the first 6 months of its release. ROI for this type of IBT site can be more difficult to assess. In part, the site replaced classroom training; in part it supplemented it. It also partially enhanced some of the informal communication channels that software engineers share by providing a means for collaborative learning.

Conclusion

The SS LEARN IBT model did not limit itself to the straightforward courseware model of the EHS ergonomics site. In contrast to both these sites, the $alTool and Bonus Tool IBT presented procedural training for a critical HR business process. The lesson is that IBT should always start with a thorough assessment of instructional needs. In the corporate world, those instructional needs will be serving a business need, and in some respect should be subject to a ROI analysis. The assumption should not be that IBT is the best solution, but that IBT should be considered with all other viable options. Many enterprises lose sight of the fact that IBT can be a very successful supplement to other forms of training. And as with any other form of training, IBT should be subject to very rigorous instructional and informational design processes. When considering IBT, it is tempting to start with a technical analysis. Start rather with an infrastructure, develop compelling, well-organized and developed content, and then turn to the technical implementation.

In any case, IBT requires a substantial commitment. It requires a very skilled project leader and development team. The larger the enterprise, the greater the complexities of developing the administrative and technical infrastructure necessary for an IBT program. With the advent of World Wide Web browsers, distributing training over a network has become easier and more feasible from a technical aspect. In effect, almost anyone with moderate technical knowledge can "put up a Web page" that can be accessed by local and remote users. Creating a seamless interface between an enterprise's other administrative computer systems, such as the Regis registration system, is a far greater technical challenge. And it bears mentioning that security issues must be evaluated by a competent network administrator. The last consideration is that IBT products require on-going maintenance. Indeed, a site like SS LEARN would lose much of its value if it was not subject to constant updates. Just like the library that needs new books, new wings, and new staff, an IBT product and program requires ongoing maintenance of content and infrastructure. When all these challenges have been met, the result can be very rewarding.

Generally, the work done by SunU's Learning Technology R&D group for network client-server technology is 2 to 4 years ahead of industry trends. In discussing computer-based distance learning, this paper has emphasized network delivery (IBT) over CD-ROM (CBT) because IBT is the best way to enable a user to send back information to the delivery system. This information can be registration information, tracking information, testing information, e-mail messages, instructor facilitation, group discussions, and other means for collaborative learning. With SS LEARN, the information sent back can even become part of the instructional content. CD-ROM can be combined with IBT to achieve two-way communication, but whenever possible, SunU has pursued a pure IBT model. In implementing technologies

which can capture, record, charge back and report, a development team can assess the efficacy of learning products and achieve accountability. This is in contrast to conventional CD-ROM CBT, where once a product is shipped, the development team loses the ability to assess use and track performance in a seamless manner. Reporting and accounting for an individual's experience will be an important enhancement to the Web browser technologies. The area of greatest interest and potential resides in technologies and instructional design that integrate the human element into the learning experience. One major shortcoming of CD-ROM CBT is that the learning experience is void of interaction with an instructor and other students. With IBT, the most profound interaction and enabling aspect of Internet and intranet learning applications will be the opportunities to learn from others. The fullest potential of intranet-based instruction lies in the ability to reintroduce human interaction into the learning experience, rather than isolating the learner from a collective learning experience.

Summary of the Workshop

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Although developments in network technology have recently stimulated considerable discussion of the promise of distance-based learning, actual research on the topic is limited. To address this dearth of information, the U.S. Department of Education's Office of Educational Research and Improvement and the World Bank held a workshop, on September 19, 1997 entitled, "Competence Without Credentials: The Promise and Potential Problems of Computer-Based Distance Education." The workshop's objective was to assess what is currently known about new technological developments in distance education, to generate discussion of policy issues relevant to distance education, and to frame potential questions for future research.

Drawing on the papers commissioned for the workshop as well as the discussions that occurred during the workshop, this paper summarizes what participants believe is the current state of knowledge about computer-based distance learning. The analysis turns first to the question of how many schools and firms are currently involved in distance education and then to what they are doing with the technology. Having surveyed current use, the discussion moves to the technical, social, and practical barriers that hamper the diffusion of technology. Particular attention is paid to the importance of context in distance education and to the difficulties of assessing competencies acquired outside traditional classroom settings. The paper concludes by charting potential directions for future research.

Prevalence of New Technologies in Distance Education

Over the last several years, a number of universities and firms have launched highly visible experiments in distance education using the Internet for delivery. What is unclear is whether these efforts are the vanguard of a larger trend toward computer-based distance education or whether they are simply intriguing but isolated experiments that are unlikely to revolutionize mainstream education. To answer this question requires determining the extent to which firms and schools are implementing or plan to implement technologies and programs to support distance education and training.

Laurie Bassis' analyses of the labor market implications of computer-based training shed some light on the prevalence of distance education in industry. The Bureau of Labor Statistics (1996) reports that 16 percent of the civilian workforce said they had received some kind of employer-provided training in 1995. However, according to the ASTD survey that Bassi cites, only 10 percent of employer-provided training is computer-based, and only one-third of that makes use of the Internet. Calculations based on these statistics suggest that last year a mere 1.6 percent of all Americans received any kind of computer-based training, and only 0.5 percent acquired that training via the Internet.

Thus, the best data currently available suggest that new forms of distance education are not widespread in industry. In fact, their use in training is rare. Moreover, the ASTD survey indicates that most employers plan no significant increases in computer-based training by the year 2000 (Bassi). Although Bassi's data only reflect training mounted by human resource departments, there is no reason to believe that training provided within the functional departments of a firm is more technologically advanced.

The situation in 4-year colleges and universities is comparable. In fact, according to Kenneth Green, most universities have not progressed much beyond the overhead projector. The 1996 Campus Computing Report, a national survey of technology in higher education, shows that less than 10 percent of college classes currently use computer-based technologies as a teaching tool (Green 1996). However, Green suggests that community colleges may make more use of these technologies, since they report having more computers in classrooms and public areas than do most colleges and universities. Furthermore, community colleges are geared toward "turnkey courses:" they repeat classes often and, therefore, are in a better position to make use of technologies that enable economies of scale.

The data presented at the workshop indicate that neither universities nor firms are rapidly adopting computer-based technologies as tools for distance education. However, it may be that these modern forms of education are most frequently used in less traditional educational settings. The popular press suggests that technological advances such as the World Wide Web can revolutionize the way we think and learn. In advertising images, people of all shapes and sizes sit in front of computers in their homes or in cafes, as well as in classrooms. These images imply that people without more traditional means of access to information could potentially exploit the opportunities that the Web offers for learning. This could mean that computer-based distance learning is primarily taking place in individuals' homes or in cybercafes.

Charles Darrah's investigation of training opportunities on the Internet, however, shows that this is also not the case. Darrah discovered that it is quite difficult for people who are searching for training to locate educational courses and other resources on the Web outside of universities and firms. Technical professionals will find a wealth of coursework teaching technical skills such as programming. However, individuals trying to employ the Web for other than computer-related training will be disappointed by the lack of educational programs available.

Characteristics of Computer-Based Distance Education

Computer-based distance education is primarily experimental and not widely used. However, the interest that experiments in distance education have generated recommends an analysis of the courses that do exist and the ways in which firms and universities are using new technologies. Rhetoric, such as that cited by Green, suggests that computer-based education will transform traditional learning in many ways: by breaking down the walls between the classroom and the real world, by transforming students from passive to active learners, by replacing text with multiple representations, by supplanting isolation with interconnection, and by changing the focus of education from the products of academic work to the process of scholarship (Green, citing Kozma and Johnston 1992). To discover if this characterization rings true requires examining the content and context of distance education programs as well as what providers of these courses know about their effectiveness.

What can be said about the content of computer-based courses taken by individuals on their own, in firms, and in universities? In his search of the Web from the perspective of an individual seeking to learn job skills, Darrah found that anyone other than information technology professionals would have difficulty obtaining training over the Internet. Most sites are targeted at people who are already knowledgeable about computers. Many of them are designed to train people in how to use the Internet effectively. Freely available courses that focus on knowledge other than computer skills are rare.

The publicly available education on the Internet, at least at present, does not appear to meet the training needs of most people. In contrast, firms and universities have a clearer understanding of the audience for their educational programs. Therefore, within firms and schools the content of computer-based distance education courses is more likely to address the needs and interests of their constituencies. The experiments detailed by the workshop participants exemplify the ways in which firms and universities are using computer technologies to deliver training to their members.

Thomas Edgerton's paper described Sun Microsytems's "electronic store," a Web site, where employees can choose and register for both instructor-led and computer-based courses. Edgerton provided several case studies of the electronic store's computer-based coursework. One training program was a short tutorial for a salary tool designed for human resources professionals. This salary tool, a spreadsheet application, was used by human resources personnel to conduct annual salary reviews. The tutorial program, which could be viewed by individuals from within the salary tool application itself, lasted for 2 minutes and was multimedia based. It was used by 43 percent of the professionals who used the salary tool.

In contrast to this short tutorial, the electronic store also offered a long-term technical training site for engineers that included both practical information and theoretical content. This site contained various features: a journal that described current engineering and technical information, and contained hyper-links to the authors of articles, a tools training section with lessons for implementation and use, as well as practice sessions, a hypertext user's manual, and a "hacks" section with work-arounds discovered by other engineers. The site had about 200 users per day.

A widely visited site in the electronic store was the company-wide ergonomics training course. Sun's training staff considered this site an enormous improvement over the previous ergonomics training. Previously, classes were conducted by an English-speaking instructor who traveled around the world providing instruction on location. The instructor-led classes were identical at all sites. In contrast, the computer-based instruction was available in many languages and altered to reflect the local cultural interpretations of the students.

Hewlett-Packard (HP) has also been experimenting with new forms of distance education. During the workshop, Bill Schott and Gary Orsalini demonstrated PlaceWare's Auditorium application and described several ways in which HP has implemented and expanded it. The Auditorium, a hierarchical presentation tool, is an online classroom in which one engineering lecturer trains other engineers. In addition to providing "real-time" electronic lectures, HP is using the program to support a distributed collaborative work group. They have developed a "Meeting Room" where engineers can "hangout" online, communicate via a message board, and share information in a collective notebook used by all members of the group.

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Private training companies are also offering distance education online. For instance, Edgerton described some of the programs provided by DigitalThink. For a charge, DigitalThink offers training for both corporations and individuals in areas such as computer science, multimedia, finance, and wines. The training is online but includes instructor-led chatrooms and discussion groups.

A number of provocative experiments can also be found in universities. For example, at Stanford University's Engineering School, students can sign up for courses using the Web, and many classes at Stanford have Web pages that serve as a repository for class notes and assignments. Oregon State has an object-oriented programming course in which there are no lectures; students submit e-mail answers to study questions and take online exams (Edgerton). Online education has expanded even further at Monterrey Institute of Technology and Higher Education in Mexico, where the Virtual University offers 11 post-graduate programs (Edgerton).

These examples illustrate that certain universities and companies have found an audience for computer-based education. They are working to address the content needs of their students, and they are trying to develop innovative ways to attract new students and keep them interested. However, much of the computer-based training in schools and firms described by participants parallels Darrah's experiences on the Web. Even here, technical skills training predominates. The narrow technical focus of these experiments may be one reason why computer-based distance education is not more widespread. Firms' and schools' failure to adopt computer-based education is probably also rooted in the characteristics and limitations of the medium itself.

Strengths and Limitations of Computer-Based Distance Education as a Medium

There has been little research to determine which forms of distance education technology are the most effective for learning or how distance learning compares with traditional education. However, several of the papers written for the workshop offer insight into the technical, social, and practical strengths and limitations of different forms of technology.

From a technical standpoint, the Internet parlays the strengths of previous computer-based educational technologies as well as adds new advantages (Darrah). The "real-time" feature of the Internet offers convenience: educational providers can rapidly update information, and students can pace themselves, learning from home at any time. The broad reach of the Internet allows providers to teach a large, geographically dispersed audience. However, technical constraints also have the potential to hobble learning. Some students may be uncomfortable with the technology and simply avoid using it. Others may be interested in the technology, but not have access to the bandwidth necessary to receive training properly, as originally formatted. This could become increasingly problematic because the literature also suggests that despite the Internet's potential for interactivity, most educational providers are not taking advantage of the features and are using Internet-based training merely to deliver basic textual information (Darrah, citing Crenshaw). If providers begin to use Internet technology to its fullest potential, they could find their student base shrinking because of technical constraints, as students have increasing difficulties with graphics and formats.

Practically speaking, the Internet can be expensive. It requires massive infrastructure, and while some firms, universities, and individuals can afford the costs, many cannot. Other practical considerations for providers include the organization of the training programs and the marketing of distance training to the proper audience. Most Internet-based training is organized in a modular fashion, and the designers creating the training programs may leave out information that does not fit

well into a particular module. While the designers know how this information fits into the training and intend for it to be delivered by live instruction, the live instructors may be unaware of the information and not have full knowledge of the curriculum. The students then would not receive all the information they need to be fully trained (Darrah).

Internet-based training also faces marketing issues, as firms must appeal to potential students to have an audience for the training. Edgerton found that the programs available in the electronic store at Sun needed to be "sold" to their audiences through such internal marketing devices as giveaways and site treasure hunts. The developers of the Sun training programs also discovered that they needed to extensively research their audience, or risk including detailed information that was only useful to a small group of people, such as senior vice presidents, that never even visited the site. To keep the students interested, educational providers must create a program that appeals to the proper audience.

In the social arena, Internet-based training and education suffers from several limitations. As Darrah explained, computer-based training is inadequate for certain types of skills such as soft interpersonal skills and high-level analytic skills. Moreover, use of the computer for training in firms introduces an "interruption" problem: when engaged in a learning module students appear to be merely sitting at their desks as usual, and therefore others assume they are available and interrupt their training. Participants in the workshop reported that in their firms, students would gather in groups of four or five in one office to participate in the computer-based training, and hang a "do not disturb" sign on the door.

If students do train alone, as opposed to joining others in an office, they experience social isolation. Since social interaction generally helps people to learn, Internet-based training that isolates students may be less effective. More specifically, job skills have social and tacit components that are often learned through membership in a community of practice. Education through the Internet eliminates this important social context of the work from the training. The Internet cannot replace a community of practice, but instead should be part of a broader program of development and training that gives workers opportunities to learn to work with other members of their communities (Darrah).

These social limitations could be ameliorated by integrating Internet-based distance education into a larger system of training that includes live instruction and group interaction. While this system is not a substitute for a work-based community of practice, students would have some opportunity to experience the interaction that provides a context for tacit knowledge and interpersonal skills. Schott and Orsalini point out that PlaceWare provides chat rooms to improve the level of social interaction among students, and that awareness video might add some social context to Internet-based learning.

Participants in the workshop testified to the continued importance of interaction in the learning process when using computer-based training. For instance, Sun used the Internet to replace training sessions in which 500 people had traveled to one site for a series of lectures each quarter. The individuals still travel to the site each quarter, but now the time is spent in more informal, interactive training, giving geographically dispersed employees the opportunity to learn from each other. Green provided an example of a Web-based college class in which the distance students performed better than the instructor-led class. The professor of the course concluded that their improved performance was due to the study groups that the Web-based class formed to compensate for their lack of face-to-face contact. Collaboration also helps employees who take classes in the PlaceWare Auditorium learn more effectively. According to Schott, most of the learning happens after the lecture, in interactions among members of the "virtual community" of peers.

Practical and Cultural Barriers to Computer-Based Distance Learning

In addition to the social limitations inherent in distance education tools, schools and firms must counter practical problems such as the costs of implementing and continuing distance education programs. At the same time, there are formidable cultural barriers to widespread learning through computer-based distance education, such as teacher skepticism and stratified access for students.

Barriers faced by schools. In universities, the cost of implementing distance education systems has slowed their adoption. As mentioned earlier, distance education is not as cheap and profitable as some assume, particularly because the hidden costs of the infrastructure are enormous. Universities also do not have the tax accounting experience to properly evaluate amortization costs, and tend to underestimate the costs of training people to use the technology (Green). Schools rarely offer extra pay for faculty to mount computer-based courses, and they pay undergraduate and graduate students meager amounts to write the code and support these courses. Faculty and students are not inclined to carry the extra burden of creating and teaching a distance education class if their pay is not commensurate with their effort.

Computer-based distance education faces cultural barriers in academia as well. The reward system in research universities is not geared toward innovation in teaching. Faculty receive no recognition for creating nontraditional coursework; indeed, there are implicit penalties for doing so. Faculty who devote extra time to preparing and teaching distance education courses have less time for research and publishing, which are the bases of the reward system in research universities.

Most faculty have also been trained through a "self-help model." As Green points out, in graduate school students are expected to debug their own SPSS programs through trial and error. Accustomed to figuring it out on their own, faculty are not inclined to seek training from others. Therefore, very few faculty are likely to seek training in how to use the resources available for distance education.

Some faculty feel threatened by the idea of distance education. They see it as part of a "management" effort to try to reduce costs without respect for the context of learning and the importance of interaction in the education process. When distance education results in students being less involved with both the instructor and their peers, educators fear that students are not learning as much or receiving the full benefit of the course. They also worry that universities may create new work rules changing the way teaching loads are determined and enrollment is counted. If these rules change, their work loads could increase.

Finally, academics are very concerned about issues of credentialing. Certification is a pivotal issue in discussions of distance education, as this paper will describe in more detail later. Assessment in postsecondary education requires more than just a multiple choice exam embedded in an online module of a program. Many university exams include extended essays or problems in which students are required to demonstrate appropriate and creative application of knowledge. It is not uncommon for faculty to assess students' learning through group projects and presentations as well. Faculty expect to use varied and flexible means to assess students' learning, and thus far the new forms of distance education have not provided them. The culture of universities creates barriers that would make computer-based distance education difficult to provide effectively even in schools that could afford the infrastructure.

Barriers faced by firms. Because many firms can afford the costs of distance education and have a cultural context that is not biased against distance education, barriers to computer-based distance learning in

industry are of a different nature. Instead, these barriers form around issues of stratified access. As Bassi notes, large firms are more likely to use computer-based training. This relates to the cost of the technology but probably also reflects firms unequal investments in general forms of training. In general, large firms provide more training to their employees, and therefore on a proportional basis would be expected to provide more computer-based training. Additionally, firms that have more innovative human resource practices are more likely to adopt distance education programs. Therefore, workers in large and innovative firms have more access to distance education than others.

At the same time, individuals' access to training is stratified demographically (Bassi). Male workers and whites are more likely to receive any type of employer-provided training than are women and minorities. Also, workers with higher levels of education receive more training. Since these workers have greater access to all types of training, Bassi infers that they probably have better access to computer-based training within firms as well.

The examination of the limitations of and barriers to computer-based distance education illustrates that these programs have not completely revolutionized learning, as popular rhetoric suggests. Indeed, computer-based distance learning seems to reproduce some of the same structures encountered by students in more traditional forms of education. However, it would also be useful to know more about how distance learning differs from traditional forms of education. An important distinction between distance learning and traditional academic learning lies in the different contexts within which they take place. These contextual differences influence students' learning both inside and outside of university settings.

How the Context of Distance Education Differs

In academic settings, the overall context for distance education differs from traditional education because of the expanded role of market forces. Green offers a description of the impact of these forces, summarized in (see table 1). In distance education, the mission of the program, curriculum, and credibility of the program are all driven by market interests, unlike the context of traditional academia, which is controlled by institutional forces. In traditional educational settings, the mission is managed by the institutional authorities, and the curriculum is developed by the faculty in alignment with their interests. The credibility of traditional education is based on the reputation of the institution itself. In contrast, in distance education the power of the market influences the mission of the program and the content of the course curriculum. The credibility of distance education relies on the market performance of the students who have finished the program and are looking for jobs in which to apply the skills they have learned.

Table 1.—The context of traditional and distance education

	Traditional	Distance
Mission	Managed by authorities	Determined by market
Curriculum	Faculty-centered	Content-centered
Credibility	Institutional reputation	Market performance of students

As Darrah described, the context of distance education plays a role in learning outside of academia as well. Darrah found great differences in the learning environment of employer-provided and individually sought Internet-based training experiences, as shown in table 2. In the context of employer-provided training, the goal of distance education is to incrementally update employees' skills and knowledge. These individuals are secure in their jobs, and find Internet-based training convenient. With employer-provided training, employees have the opportunity to assess and implement what they have learned within the community of practice in which they are working. They are certain that the organization values the skills they have learned, because their employer has defined and provided the training for them. In contrast, when individuals seek Internet-based training outside of a firm, the experience is much more of a gamble. Individuals may be seeking to transform their work lives. This often results in stressful personal conditions, as they feel a sense of urgency because they do not have a job or they want a new type of job. Because these individuals are not already working in the field in which they are obtaining training, they do not have the opportunity to implement or assess their new knowledge and skills within a community of practitioners, and must take the risk that what they have learned will not be valued by potential employers.

Table 2.— Context of distance learning: Employer vs. individual perspective

Aspect	Employer	Individual
Goals	Incrementalism	Transformation
Personal conditions	Secure in job	Urgent because jobless
Convenience of IBT	Important to learners	May not have access
Opportunity to implement learning	Available; learners in a community of practice	Less available; learners more isolated
Opportunity to assess validity	Yes, because learners are working	No, because learners do not have job
Organizational contribution	Organization identifies needs and curriculum, defines what counts as training and assessment, provides technology	Learners have to find own technology, have to judge on their own whether training is useful

Unresolved Questions Concerning Distance Education

Most of the discussion among the participants resulted in raising questions about distance education rather than resolving them. One serious issue in the development of computer-based distance education is that of credentialing. The learning environment of distance education differs from that of traditional education, but both types of programs are faced with a similar problem of competence assessment. Educators everywhere are regularly challenged by the issues of competence and credentialing; they need to determine whether individuals have learned from a particular educational program. Similarly, learners want to be provided with a means to "prove" to others that they have learned. This problem is further complicated by the new environment and learning context of distance education.

Workshop participants suggested various reasons for the value of credentials in the marketplace. Credentials can serve as a signal of an individual's skill, as a reflection of status, and as a foundation for an individual's sense of identity. First, credentials are indicators that an individual has completed a program of

education, and as such, they reflect a certain level of skills, knowledge, experience, and ability to learn. Receiving a credential signals to an employer that a potential employee has achieved this level. The credential often serves as a baseline of assessment for employers, a starting point at which they can assume the skills of potential employees.

An educational credential is not always necessary to signal learning. As Bassi illustrated using data from the Bureau of Labor Statistics, an additional year of education, regardless of an additional credential, is linked to increased wages. This indicates that the labor market is willing to reward people for education without a credential, probably because employers perceive that they have acquired additional skills and knowledge. However, a credential is the most obvious signal that an individual has acquired these skills.

Credentials are also an indicator of status, and are differentially valued in the marketplace. A credential from Harvard is worth more to some employers than one from the University of Chattanooga, and is evaluated differently than a credential from SunU at Sun Microsystems, as one workshop participant pointed out. This is both because of the differential mastery that they represent and the symbolic value of the credential. A Harvard degree is valued not only due to the standard of training at Harvard, but also due to Harvard's status and name recognition.

Credentials are important to individuals because they represent attainment of educational goals; however, as participants indicated, credentials also matter because they are linked with people's identities. People value their degree both because it helps them to get a job and because it depicts who they are and gives them feelings of self-worth. Whether a credential is a Ph.D. in economics, a degree in cosmetology, or Novell certification, it reflects an individual's interests and expertise and suggests what is important to them.

Issues of Credentialing in Computer-Based Distance Education

One workshop participant entitled credentials the "coins of the realm." Since credentials are the currency of the labor market, it is important to determine how credentialing differs in the age of computer-based distance education. Participants pinpointed problems with credentialing such as the spotty availability of certification, institutions' lack of accreditation and status, and the questionable transferability of distance education credentials.

Credentials are not uniformly granted by providers of computer-based education in either schools or industry. Many schools and employers that offer distance education courses do not certify their completion in any official way. There are no accreditation boards to ensure the standards of distance education programs, as there are for traditional universities and professional schools. Also, many of the institutions with computer-based distance education programs are perceived to have lower educational quality and less prestige.

This lack of uniformity raises technical and legal questions about credentialing for distance education programs. Participants agreed that we do not know how the content of distance education courses compares to that of traditional coursework. For instance, when a chemistry professor designs a course for the Web, she may include content that crosses the boundaries of a traditional chemistry course sequence. Also, the student enrollment is not restricted to those who have taken the prerequisites, as in a traditional university setting. This leads to several unanswered questions: Does the content of Web coursework differ from that of traditional coursework? Also, in cases where the coursework seems to be similar, do students

in the two courses learn the same things? Finally, whose role is it to assess these new distance education courses: universities, industry, boards of standards? Research is needed to determine the answers to these questions.

Another problem with credentialing emerges from the different perspectives of the constituencies involved in distance education. Since many firms now provide distance education to their employees, the transferability of credentials has become an issue. For instance, a credential from SunU, indicating that an individual has learned to use a certain type of software, may have great value to some other firms in the marketplace. However, it is not ubiquitously transferable. While students are interested in furthering this portability, firms view it as less of a priority. These different understandings of the importance of credentials shape our understanding of what needs to happen institutionally for distance education to gain a strong foothold in our educational system. More research is needed to discover what the constituencies' priorities are, and how each group thinks about credentialing for distance education.

Distance-Based Learning and the Assessment of Informal Knowledge

Another issue participants raised in the course of discussion addressed the types of knowledge that could be effectively learned at a distance. Credentials have garnered increased attention because assessments of work have become more complicated. Work has become more technical and service-oriented; many of today's jobs have cognitive and social aspects, which makes ascertaining people's competence difficult. Employers do not find it problematic to assess formal, codifiable knowledge such as arithmetic: they simply administer a written test. Even less codifiable skills such as computer programming are easily assessed though less formal means. For instance, Gary Orsalini often interviews applicants for Hewlett-Packard and needs to determine if a prospective employee is skilled at Java. His solution to this assessment problem is to simply visit the applicant's home page on the Web to see what they can do.

Employers feel comfortable with their assessments of formal knowledge. However, they are realizing that the more informal skills of problem solving, communication and teamwork are more important for the success of their organizations, and are clamoring for ways to assess these skills. What makes assessment difficult is that the content of informal knowledge is variable and sometimes tacit, and the process of learning is undefined. Skills such as problem-solving, a "feel" for materials, and critical thinking are learned informally, through practice and interaction with others, rather than by sitting in a classroom and studying a body of codified knowledge. One alternative for employers is to assess these skills during real-life problem solving situations. This type of assessment is not easy, however, and can be costly. Schools and employers have yet to determine a simple way to certify the competence of individuals at problem solving and critical thinking.

It is clear that with the changing nature of work, an increasing number of jobs will require interpersonal skills and informal knowledge. Because certifying competence in these skills is difficult, employers are turning to distance-based learning as a way to try to teach and assess them. However, workshop participants concluded that distance-based education may be unable to provide either the training or the credentials to help the market properly evaluate those skills.

Currently, as Bill Schott indicated, most firms are primarily interested in using technology to teach formal knowledge that is easily certifiable. According to Schott, this reflects the concept of education with which corporate America feels most comfortable. The market did not respond to Schott's initial attempts to

provide PlaceWare technology to aid in developing informal knowledge. As Darrah found out when looking at the Web, most Web-based training is also used to teach formal and easily assessed skills.

The flexibility of distance learning technologies allows them to be shaped to fit particular types of knowledge, depending on the goals and intentions of the organization and the demands of the market. This flexibility and convenience may appeal to employers looking for a quick solution to their assessment problems. However, as described earlier, distance education is seriously limited in its ability to teach and assess interpersonal and high-level skills. If employers adopt distance education as a way to teach and credential students, the context in which distance learning occurs assumes more importance. Particularly in cases of informal skills learned in a community of practice, if a distance learning program has not been incorporated into a larger curriculum of interactive learning, a credential from that program may be an inflated indicator of the learning of those skills. Clearly, the discussion of participants did not definitively answer questions about whether distance learning could teach these types of skills effectively. What is needed is further empirical investigation of the types of skills that can be effectively taught through distance education and how to improve and integrate coursework.

Comparative Implications of New Forms of Distance Education

This also suggests that an investigation of traditional education is needed in order to benchmark the findings of studies of distance education. What types of training are used most and what educational practices are most effective? Charting the progress and documenting the consequences of traditional educational practices can provide a baseline for analyzing the impact of the new types of distance education. For instance, the processes of teaching and learning can vary dramatically in their degree of formality. A classroom lecture might teach the basics of chemistry, for instance, but informal interaction in the laboratory is often just as important. While participants broached the question of informal learning processes, there were no conclusions about how they might be implemented through computer-based education. Further research comparing traditional practices and investigating informal learning processes is necessary to gain insight into how these processes could be taught via distance education.

Firms and universities are searching for new ways to teach skills and impart knowledge, and new technologies could help fill this need. To determine how they might do so, we need to look systematically at the impact of changing technologies in education on both teaching and learning practices. How are the Web and other computer technologies integrated into various learning settings? How do they enhance traditional aspects of education? Green suggested that universities are not making large enough investments into these new technologies, but without empirical data on their importance in education, we cannot be sure that this investment is wise.

Participants agreed that it is vital to understand the social implications of these new forms. While the popular press suggests that distance learning has the potential to make learning much more egalitarian, both Bassi and Darrah point out that this may not truly be the case. More definitive studies of the social implications of distance learning could create a better understanding of the equality of the learning experience.

The prospects for technology in distance education programs are still undetermined. Further study of the practical, social, and cultural implications of the use of technology in education will illustrate the relative effectiveness of these new forms. This research would provide insight into the context and process of learning and could help shape distance education programs in the future.

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Conclusion

Nevzer G. Stacey

At least four major concerns surfaced from the discussions on the use of technology in teaching and learning: rising costs of higher education, the importance of time and location for working students, the changing meaning of traditional credentials for employers, and computer-based knowledge and skill delivery systems.

The uses of technology are varied. How individuals use technology, how much they use it, and for what purposes are influenced by personal views of the value of technology. Given the ambivalence about what technology will do for society, and a competitive market reflecting the creativity of millions of course developers worldwide, the most appropriate action to take is to understand how computer-based education may help us improve our careers and the quality of our lives.

However, before discussing these concerns, the terms of discussion, such as distance learning, computer-based education, and learning on the Internet, need to be clearly defined. Participants in the workshop brought their own definitions, and each participant's work was clearly tied to those definitions. This raised the importance of reaching a common understanding of the intrinsic meaning of various terms in this field. For example, participants from the world of higher education were more comfortable referring to the many technologies as "distance education," implying that such learning had always been outside the main focus of the academic world, and thus was not much of a threat or concern to them. They perceived computer-based learning to be lacking in many dimensions necessary for imparting broad-based knowledge. It was also hard for them to see how this learning would ever replace traditional learning. If the participant was from a high-tech firm, the term used was "computer-based training." The employers were interested in teaching their employees new knowledge and skills as quickly and efficiently as possible. They were not interested in transportability of credentials. How employers would provide their employees with knowledge and skills to remain competitive in the world market was the important question. Most importantly, employers were clearly seeking a quick way to assess competencies in hiring new workers. Therefore, the problems were not simply definitional problems, but carried with them participants' experiences and values.

The workshop attempted to respond to the concerns raised by the National Institute on Postsecondary Education, Libraries, and Lifelong Learning. For example, what are the financial implications of computer-based education? Learners and policymakers, who are concerned about the rising cost of higher education, see computer-based education as an ideal means of cost containment. Tuition costs have been increasing steadily and college loans have become burdens to college and university graduates. Given the increasing demand for higher education, debts accrued by individuals who pursue graduate or professional education may increase significantly. If these trends continue, and the cost of computer-based education keeps going down, then students may be increasingly interested in a certain trade-off between a degree earned on campus and a degree earned through computer-based education, which may cost much less. There are already other significant changes in the American landscape of colleges

and universities, such as increased part-time enrollment, that could create greater demand for computer-based education. What are the costs of maintaining an infrastructure for computer-based education, and how cost-effective is it? If computer based education can provide the latest information in the most economical way, how can traditional institutions compete with that? If there are fewer and fewer traditional classrooms in colleges and universities, will traditional institutions lose money? How will the teaching staff be affected?

Is it more cost-effective for employers to have their employees take courses at their workstations, without going to training sessions? A second concern is the question of time and accessibility. As noted above, increasing numbers of learners are attending colleges and universities and working simultaneously. Scarcity of time is an important issue for these learners. It would not be surprising to see that these students turn to computer-based education for acquiring knowledge and skills on their own time and at places more convenient to them. Even if they cannot afford to have private computers, alternative settings (e.g., libraries, work settings) might assume a new function by turning their facilities into classrooms for adults. Do such courses address the problem of accessibility for people who have to travel long distances to get to educational institutions, or for people who are too tired to leave their homes after a day of work? How important is accessibility to employers who are interested in providing education and training to their employees? If highly scientific education is mostly provided through high-performance workplaces, what will happen to individuals who are unemployed or who are working for less sophisticated firms?

Another concern deals with the ambivalence about the nature of computer- based education. For some, computer-based education is simply an additional tool to augment traditional learning. For others, computer-based education is the only way to keep up with the most recent developments in the field. Employers who have used high school diplomas and college degrees as signaling devices may be looking for alternatives. Traditional credentials and certificates appear to be losing their values for employers. Computer-based education may become more and more attractive and may become an alternative to them. As computer-based education becomes more and more universal, and more students from diverse backgrounds learn from it, it may provide a larger pool of candidates for employers to select from. If employers, who have used educational credentials for recruiting employees, now realize that more and more learners are relying on what is provided via the Internet, how will this affect their hiring processes?

And finally, there are concerns about the nature of the technology. If one acquires a degree through computer-based education, does one become a member of a graduating class of unknown size? Do you become a member of a "club?" Alumni of traditional educational institutions keep in touch, providing references and helping to make the "right" connections for jobs. But all these concerns may be irrelevant since many prestigious universities have already started to market their own computer-based courses; among them are Stanford University, the University of Pennsylvania, and a growing number of state universities. Is there a difference between a degree received from a university by sitting in the classroom and a degree received from the same university through taking courses that are offered through the Internet? Are the credentials the same? How do we assess competencies acquired through computer-based education and the role such credentials play in the education and the labor market? What are appropriate roles for universities, industry and boards of standards vis-à-vis assessing courses on computer-based education? More importantly, at the high end of the learning experience, will only the learners who have access to sophisticated software packages be able to design cutting-edge projects?

Other questions need answers as well. No doubt technological change will continue at an astonishing rate and technology will keep reinventing itself. The workshop confirmed the need for data and research. Other significant gaps in our knowledge included:

- The problems rising from the fact that most computer-based training is organized in a modular fashion, and the designers creating the training programs leave out broader important information that does not fit well into a particular module thus narrowing the scope;
- The inability of computer-based learning to teach "soft" interpersonal skills and high-level analytic skills;
- The comparison between the traditional education environment and the computer-based learning environment;
- The problems associated with the scarcity of certification, nontraditional institutions' lack of accreditation and status and the transferability of computer-based learning credentials; and
- The need for further empirical investigation of the types of skills that can be effectively taught through computer-based education.

This workshop, in a small way, opened the door to further discussions and shed some light on issues that appear to have multiple meanings. We hope that the reader has found this information helpful in both clarifying some issues and identifying what needs to be done to get a better understanding of the promise and problems of computer-based education.

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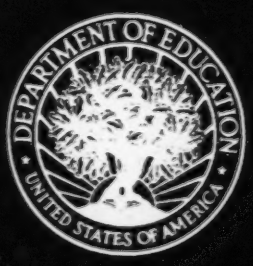

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